Chemical & Process Engineering

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Radiation—Harwell's Offer to Industry

INDUSTRY has not yet come to appreciate that radiation from nuclear fission products is a powerful new tool which may bring drastic changes to many manufacturing processes. Radiation can be used not only to change the physical properties of materials but also to effect new chemical reactions. As an example of the former we have the irradiation of polythene to increase its resistance to heat—chemical processing equipment has been fabricated from irradiated, insolubilised polythene which is capable of withstanding temperatures up to 350°F. Turning to the chemical effects of radiation, it has been found that some processes which normally require high temperatures and pressures have, when used in conjunction with radiation, taken place at quite low pressure and at ordinary room temperature, with a corresponding saving in plant costs. The manufacture of polythene is one example. In addition, radiation offers a means of producing many plastics which could not be made by conventional methods.

The usefulness of radiation is not by any means confined to the chemical and plastics industries. In the rubber industry, to take another instance, radiation can be used in the vulcanisation process, having particular advantages where silicone rubbers are concerned. The use of radiation also enables vulcanisation to be speeded up considerably. Another promising use for radiation is in improving the properties of germanium when used in transistors, and this could have an important effect on the development of rapid electronic computers. This is a field in which British scientists are ahead at the moment. Where the Americans have a big lead is in the sterilisation of food by radiation—a technique which looks like proving a formidable rival, or even successor, of refrigeration.

All these are but random instances of what radiation can do. The subject is still in its infancy and, in any case, industry has not yet had a chance to make use of this new tool.

In Britain, however, the United Kingdom Atomic Energy Authority has now taken an important step with the formation of a new organisation which will not only carry out research on the uses of radiation but will also be able to place at the disposal of industry equipment and materials for the same purpose. This new development owes its origin to the fact that stocks of fission products have already accumulated and, as the British programme for producing power from nuclear energy is implemented, large quantities of radiation will be made available for useful purposes. Besides fission products, the new organisation will make use of Van de Graaf machines and specially constructed linear accelerators.

One way of utilising the radiation from fission products is to use, without any processing, fuel rods which have been withdrawn from the reactor. Normally these fuel elements are stored for a time to allow some of the radiation to die away. During this storage period they can be used as radiation sources. After this storage period the fuel elements are processed

to recover the original uranium and the plutonium produced from it while it is in the reactor. Residual liquors from this process contain the fission products. These can be evaporated and the 'gross fission products' used as a source of radiation. For some purposes it may be preferable to isolate individual fission products such as caesium 137 from the gross fission products.

The form in which the fission products will be used will depend on the requirements of each individual application and will be chosen bearing in mind the cost, the maximum size of source permissible and the half-life of the fission products. Whatever form is used the effects of the radiation are unaltered. (The half-life is the period during which the radioactivity decreases by half.)

The Technological Irradiation Group, as it is called, is initially being set up at Harwell, but it is expected to move to a new site and set up new facilities in the near future. The new group will not only be able to undertake all the necessary irradiations for industry but will also give advice to industrialists and scientists in industry on possible radiation applications which would benefit industry. Irradiation cells which are now being built are the biggest of their kind in Europe and will enable this group to make any foreseeable irradiations necessary.

The new scheme will not only be beneficial to industry but will certainly go a good way towards solving the problem of radioactive waste disposal, at least as far as caesium 137 is concerned. Strontium, which has not proved as useful as caesium so far, will still remain a problem.

New organisation will focus nuclear energy knowledge

THE announcement about the radiation scheme came a few days after the news of another development which also augurs well for the industrial development of nuclear energy in Britain. This was the formation of an organisation by the Institutions of Civil, Mechanical, Electrical and Chemical Engineers which will serve as a common ground between scientists and engineers concerned with nuclear energy developments. It will be known as the British Nuclear Energy Conference and its affairs will be managed by a board consisting of three representatives from each of these societies. The chairman is Sir Christopher Hinton, managing director of the Industrial Group of the United Kingdom Atomic Energy Authority, while among its distinguished members is Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell.

The five societies will arrange for the presentation of papers dealing with nuclear energy subjects, and all members of the societies concerned will be able to attend and take part in the discussions. The board proposes to hold its inaugural meeting in the autumn, at which a symposium of lectures will be delivered on the technology of nuclear energy and its applications.

The organisation will promote national and international conferences from time to time and arrange for British participation in international meetings. The expenses of the conference will be met by the societies, although it should be self-supporting once it is fully established.

Chemical engineers and man-made fibres

ON another page in this issue appears a picture of Courtaulds' new plant for producing 20 tons/week of viscose rayon. This plant—one hesitates to call a unit of this size a 'pilot' plant—is one example of the important part that chemical engineers play in the research and development side, as well as on the production, engineering and administrative side of the company's activities. It is interesting to recall that at the recent O.E.E.C. conference in London (reported in our May and June issues) Mr. C. F. Kearton gave an extremely interesting picture of the chemical engineer's role in the scientific and technological organisation of his company, and incidentally provided a glimpse of research and development as it is carried out by Courtaulds.

Even when a new fibre looks promising, there is a long, expensive and difficult road to travel before the point is reached at which a real assessment of commercial prospects can be made. The pattern followed in the Courtaulds organisation is that a chemist, or more normally a team of chemists, develops a polymer which shows fibre-forming properties. The actual fibre may be produced from the polymer by melt spinning, dry spinning or wet spinning according to the nature of the polymer. Tensile tests may show interesting strength, extensibility and elasticity characteristics.

Chemical engineers now begin to be attached to the project. Rough flowsheets are built up by them and sighting shots are made at capital and production costs for various outputs. Further work is carried out by chemists and chemical engineers, and their collaboration leads to a process developed from its earliest days with continuous operation in mind, so that it is the more readily scaled up.

When a new fibre has survived the hazards of infancy, a point is usually reached where a pilot plant costing £50,000 to £250,000 must be contemplated. Flowsheets for such plants are drawn up by chemical engineers, who also play a part in further design work.

When the pilot plant is built, a high ratio of staff to operatives is usually required in the early stages. Staff are drawn from production as well as the research and development department, and it is the aim to have a chemical engineer on each shift. While textile technologists, physicists and others are concerned with evaluation of the fibre, the chemical engineer is concerned with efficiency of operation, control of process variables, and collection, co-ordination and digestion of records. When a unit operation in the process is giving trouble, an auxiliary team of chemical engineers concentrates on the specific problem. The manager of the pilot plant can be either a production man, chemist or chemical engineer. Managerial ability,

Comical Engineering Terms

"TURBULENT FLOW"

leadership, judgment and temperament are as important as technical knowledge in this post, and these qualities are individual rather than professional. Nethertheless, the experience of the post-war years has indicated that the proportion of mature chemical engineers possessing managerial ability is high.

Tannery processes and corrosion

THE atmosphere of a tannery is one of the most highly corrosive of industrial atmospheres. Humidity is high and SO_2 or other corrosive vapours are often present. An additional hazard is the danger of harmful corrosion products dropping on to the skins and hides. For the construction of the framework of machinery, cast iron or steel are the accepted materials; to replace these by less readily corroded metals would usually be uneconomic and reliance is placed on paint or sprayed coatings for protection. However, for metallic parts that come into intimate contact with liquor or goods, metals must be carefully chosen. An interesting discussion of this question was provided in the June issue of our associate journal, *Corrosion Technology*, by Dr. F. E. Humphreys. In the course of this he summarised briefly the investigations that have been made over a number of years regarding the use of different metals in the various stages of the tannery process, in which the liquors vary from strongly alkaline to strongly acid.

The first stage in tanning is to soak the skins to get them back to as near the freshly flayed conditions as possible. Salts may be added to the soak for dry hides. The soak liquors will obviously contain salt and may be acid. Copper alloys are not recommended for this stage, although *Monel* metal is claimed to be very satisfactory. Nickel, stainless steel (14% Cr) or *Staybrite* (18/8% Cr/Ni and Mo) should be quite suitable, it is stated. In order to remove the hair, hides are immersed in suspensions of lime, often containing sodium sulphide and caustic soda. Lighter skins are often painted with a paste of lime and arsenic sulphide. *Staybrite* and pure nickel have been recommended; stainless and *Monel* should be quite suitable. For deliming liquors, which are dilute solutions of acid, often organic, *Staybrite* steel is recommended.

Pickle liquors are amongst the most corrosive liquors used in the leather industry; they are very acid (about *p*H 2) and contain a fairly high proportion of sodium chloride. The acid used is usually sulphuric, but hydrochloric or formic may be used. No metal is really resistant to such conditions. However, Dr. Humphreys points out that *Inconel* seems to be the best and then nickel, while *Staybrite* steel and *Monel* metal are fairly good.

In certain parts of tanneries where humidity is high and sulphur dioxide present in appreciable quantities, the application of paint to ironwork does not give satisfactory protection. Most satisfactory results are obtained by wrapping the ironwork with a grease-impregnated tape. Of the paint systems tried, none gave longer life than a linseed-oil-based system with a red lead undercoat and an excluding top coat.

Chemical industry for Iceland?

A RECENT survey of Iceland's resources has shown that this nation of farmers and fishermen could achieve an industrial economy with the aid of research and adequate capital. The island possesses potential water power for generating about 4 million kw. of electricity. Another source of energy is terrestrial heat which, in the form of natural steam and hot water from springs and wells, is used for domestic heating. Among the available minerals are perlite, clays (limonitic, halloysitic and anorthositic—these eventually may be useful for producing aluminium), peat and lignite, diatomaceous earths, fine white silica, and limestone in the form of fossil shells (about to be used in the production of cement).

Dr. B. Gonser, technical director of Battelle Institute, Columbus, Ohio, is certain that a large chemical industry is a good possibility. He points out that with electric power and natural steam available, salt, caustic and chlorine could be produced from sea water at low cost. An ammonium nitrate plant is already in operation. The larger power potential may also be used to produce magnesium from sea water and aluminium from imported alumina.

Because of the island's location, raw materials could be shipped to, and semi-finished materials from, the ice-free harbours at relatively low cost. Moreover, Iceland is easily accessible to markets on both sides of the ocean, thus giving it a naturally advantageous location as an industrial nation.

I.C.I. and scientific research

AN example of how a great chemical manufacturing concern can contribute to the general advance of scientific knowledge is provided by Imperial Chemical Industries Ltd., which itself carries out a great deal of basic scientific research. During the last few years

the company's system of grants to university departments of chemistry for the purchase of chemicals and apparatus has been extended to include departments of chemical engineering, mechanical engineering and metallurgy. The I.C.I. Research Fellowship scheme now includes the University of Wales, and substantial grants have also been made towards the cost of buildings and equipment for research at a number of universities including Cambridge, Edinburgh, Nottingham, Oxford, Southampton and the Royal Technical College, Glasgow.

A further contribution to the general advance of scientific knowledge is the publication of the results of the company's more fundamental work, and in 1954 some 350 papers, articles and lectures on scientific subjects by members of the company's staff were published.

In the company's annual report, which we covered in our last issue, it is pointed out that, in any assessment of technical manpower in the chemical industry, the chemical engineer must be recognised as increasingly important. About 100 chemical engineers who have graduated as such, or who have added post-graduate studies to a degree course in chemistry or engineering, are engaged in development, plant design and in other fields in the company; and in addition there are many hundreds more who have graduated either as chemists or engineers and have become chemical engineers by reason of their added experience in industry.

Plastics and patents law

THE patent laws of all countries in the world have a common denominator which is that any new and useful process or article may be the subject of the grant of a monopoly as a reward to the inventor for inventing and disclosing it. Some countries grant patents for new chemical compounds so that, for instance, in the United Kingdom and the United States a new chemical compound may be protected irrespective of the process by which it is produced.

Patents for inventions in the plastics field may be granted for entirely new processes for manufacturing resins and for improvements in the manufacture of known types of resin and, furthermore, special compositions of resin may also be the subject of a patent. The question of patent practice as it relates to the plastics industry was discussed at the recent British Plastics Convention, in London, by a chartered patent agent and he pointed out that it is not clear that the protection afforded to new chemical compounds could be extended to plastics, since their molecules are usually so complex that the exact identity of two plastics cannot be asserted with certainty.

On the other hand, comparison of the process by which an infringing plastics material is made with the process defined in a patent is easy and thus it is probable that, in the majority of cases, process patents are to be preferred. The product of a process is covered by a patent for the process, since the sale of the product is an infringement of the sole right granted to a patentee to make, to use and to vend his invention.

Canadian market for chemicals and chemical plant

A REPORT on trading conditions in Canada, issued by the Board of Trade recently, contains several pointers for exporters of chemicals and chemical plant. One of these is that, during last year, Canadian imports from all sources fell by about 3% as the range and volume of Canadian production (notably 'bulk' chemicals and raw plastics) increased. Exports from the United Kingdom fell less severely (from £7 million to 6.9 million), but this was largely the result of good sales in the pharmaceutical and in the paint and pigment trades. Developments of petro-chemicals in 1954 provide capacity to meet Canada's current needs of polyethylene, pentaerythritol, formaldehyde, phenol, ethylene glycol and polystyrene.

The pulp and paper industry operated at full stretch in 1954 and, after a 5% increase in output over 1953, had large expansion projects. Although the rather specialised plants for these projects are required more quickly than United Kingdom deliveries usually permit, the new mills will increase the demand for process chemicals (caustic, chlorine and sulphur).

Mineral production has been the most buoyant sector of the Canadian economy and seems likely to remain so. In 1954, United Kingdom firms noticeably increased their share in the valuable market offered by the expanding Canadian mining industry, but their contribution remains small. Another field for which plant will be required is the cement industry, in which large expansions are taking place, while an increased demand for pipe, pumps and valves will result from the big natural-gas projects.

Turning to the market for pumps in Canada, including pumps for the oil, chemical, pulp and paper industries, the exporter finds a much more definite picture. For the chemical and allied industries there is an ever-growing market for high-vacuum pumps, while the oil fields in western Canada offer a good but difficult market for slush pumps, and refineries and chemical plants are always looking out for proved and more efficient non-clogging pumps and corrosion-resistant pumps. Heavy reciprocating pumps are sometimes in demand for handling hot oil and other sticky substances, but there is a preference for centrifugal pumps for most refinery and chemical plant requirements. Pumps for handling sludge and semi-solids are in heavy demand in the pulp and paper industry.

However, while extensive markets exist in Canada for pumps, there is no paucity of North American sources of supply, and competition is fierce. With a few exceptions, pumps of United Kingdom design are generally acceptable in the Canadian market, and their prices are generally competitive, but aggressive advertising and promotional work is vital to secure orders. The Board of Trade have issued a circular (Reference No. CRE/463/55) in which British pump manufacturers who are contemplating this market would find some useful pointers.

OILS AND FATS PROCESSING

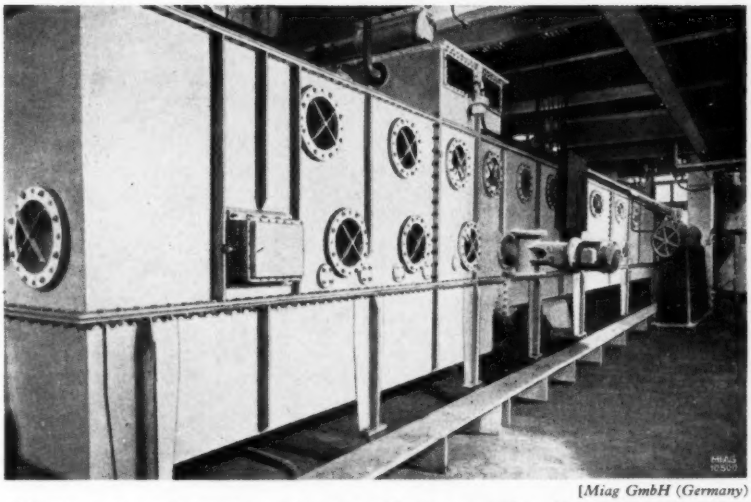
World supplies of oils and fats; vegetable oil developments; fish oils; food fats; fat chemicals

By M. K. Schwitzer, M.I.CHEM.E.

Some economic aspects

AVAILABILITY and price of oils and fats have a decisive influence on their utilisation and technology. It is therefore not out of place to preface this annual process review with a brief summary of the supply position of oils and fats. When the last war had ended, world production of oils and fats was about 18 million tons, compared with about 21 million tons in the immediate pre-war years. *Per caput* world consumption in 1938 was 21.4 lb., but fell appreciably during the war. By 1954, consumption had regained its pre-war level. In the intervening period, world population had increased by about 18% and so had the supply of oils and fats. This greater supply is almost entirely due to the growth of vegetable-oil production. World vegetable-oil production was about 18.8 million tons in 1953-54, the largest ever recorded. In comparison with pre-war, the increase was approximately 25%.[1] World animal-fat production, on the other hand, had increased at a slower rate than world population; though there has been an increase in the production of tallow and lard, butter output has fallen: it amounted to 2.57 million tons in 1953, a drop of some 300,000 tons since 1938.[2] Marine oils, which are only a minor factor in the world supply of oils and fats, are also in shorter supply than they were before the war.

Whereas there has been a contraction in the volume of butter processing over the last years, there has been an appreciable expansion in the vegetable-oil-processing industries. It should also be recorded that there has been a slight decline in the industrial utilisation of oils and fats—especially in the soap industry—and therefore a somewhat higher proportion of fats were available for food purposes. The increase in the amount of food fats consumed has been particularly marked in the post-war expansion of the margarine industry. Production of margarine in the main producing countries is given in Table 1. By 1953, margarine output was nearly double that of 1938. Cooking-fat, respectively shortening, production increased from 868,000 tons in 1938 to 1,066,000 tons in 1953.



[*Miag GmbH (Germany)*

Side view of a unit for the continuous solvent extraction of oilseeds and cakes.

Table 1. World Production of Margarine, 1938-53[1]

Country	*Production (thousands of tons)*			
	1938	1948	1952	1953
U.K.	208	407	445	406
Canada	—	—	47	47
U.S.A.	172	405	574	577
Germany	439	(100)	502	573
Holland	70	106	183	198
U.S.S.R.	116	118	(220)	(270)
All other	375	360	515	547
World total	1,350	1,496	2,486	2,618

A significant change, reflecting the economic conditions, has taken place in the type of principal oils used in the U.K. for margarine production. The amount of vegetable oils entering into margarine more than trebled since before the war: *i.e.*, in 1953, 310,000 tons were used, compared with 101,000 tons in 1938. Over the same period the use of marine oils (mainly whale oil) declined from 67,000 to 30,000 tons. Palm oil, of which hardly any was used in margarine before the war, accounted for 69,000 tons of U.K. fats in 1953 (82,000 tons in 1952). This was made possible by improving production and processing techniques developed during recent years. A similar development took place in the U.S.A., where soya-bean oil accounted for 324,000 tons of margarine fats in 1953, compared with 18,000 tons in 1938. Over the same period the share of cottonseed oil in American margarine increased only from 64,000 to 123,000 tons.

Vegetable oils

New data on some commercial as well as on some rarer oils have become available. Only a few of these can be mentioned here. Dale and Meara[3] investigated coconut oils from Indonesia, the Solomon Islands and Ceylon, and compared them with previously published data. The component fatty acids and glycerides of the three oils were isolated. The new data, taken in conjunction with earlier

analytical figures, indicate that the composition of coconut oils produced in widely scattered regions remains practically constant. The oil consists of a very complex blend of mixed triglycerides, only two components of which, namely, myristodilaurin and lauromyristopalmitin, occur to the extent of over 10%.

The same authors[4] also investigated a sample of palm kernel oil and found that 27.2% of it consisted of myristodilaurin, 12.2% of caprolauro-olein and 10.6% of lauro-myristo-olein. No other component occurs in an amount greater than 10%.

Argoud[5] investigated palm oil and especially its unsaponifiable matter. Unsaponifiable matter from pressed and from solvent-extracted palm oils was analysed. In certain instances, lycopene was found to be present in addition to alpha, beta and gamma carotenes. A number of new substances not hitherto detected in the unsaponifiable were also identified.

Fuhrmann[6] has carried out a most comprehensive piece of research on characteristics and fatty acid composition of olive oils obtained from Tunisian press residues; a thorough analysis of the unsaponifiable matter of the oils is included.

Lofland and Quackenbush[7] investigated 392 samples of maize corn. The oil content of these samples varied from 1.13 to 13.80%. Saturation of the fatty acids increased with increased oil content; iodine value decreased from 147.4 to 88.4. Linoleic acid content of the oils varied between 15.7 and 67.6% and was inversely proprotional with the oil content of the seeds. Oleic acid varied from 16.5 to 75.9% and saturated acids from 0 to 21.30%.

American tung oils were investigated by Holmes *et al.*;[8] 74 samples of oil were investigated with the following results: sap. val., 190.7 to 193.6; acid val., 0.28 to 3.92; iodine val. (Wijs), 157.8 to 165.9; density at 25/25°C., 0.9351 to 0.9378; refract. index at 25°C., 1.5147 to 1.5187. The following acid composition is recorded: alpha-elaeostearic 55.6 to 85%, beta-elaeostearic 0 to 23.1%. American tung oils can therefore be regarded as very homogeneous products.

A very useful review of the characteristics and composition, as well as production methods of a variety of commercial oils is published in serial form.[9] The review covers marine and land animal oils as well as vegetable oils. A very comprehensive work on vegetable oils and fats was recently published by Eckey, and is referred to later in this article.

Oilseed harvesting and oil production

Progress in the mechanisation of harvesting methods of several types of oilseeds is reported. To facilitate mechanical harvesting, chemicals are used which help the ripening process of the oilseed-bearing plant and which speed up its defoliation. A typical application of such chemicals is in the harvesting of cotton. These chemicals are either in the form of a dust or are sprayed as aqueous solutions. Aeroplanes are used for spraying. Dust is used only when there is a heavy dew or when air humidity is high. Due to the hygroscopic nature of the chemicals, the solid particles dissolve in the dew drops, respectively, in the moisture absorbed from the air. Pentachlorophenol, potassium cyanate, sodium monochloroacetate and others are used for defoliating purposes. Cotton plants thus treated are harvested by mechanical pickers or snappers.

Soya beans are harvested by means of specially designed combines such as the one made by J. I. Case & Co. Inc. The harvesting of groundnuts, linseed and sunflower seeds are other examples where mechanical harvesting methods have been introduced.

Advances in oil production methods of many commercial oilseeds are reported. Most reports deal with solvent extraction, which method is gradually superseding mechanical pressing. Spadaro *et al.*[10] state that the filtration-extraction process for cottonseed has been improved and refined. These improvements include principally certain modifications in the method of conditioning the flakes prior to cooking and in the procedure for crisping. An improved filter medium has been used which is more durable and has a lower fines retention; a better method for the clarification of the solvent miscella has been discovered by recycling it continuously through the cake formed on the filter. A bench-scale method for evaluating the processing characteristics of oilseeds for the filtration-extraction method has been developed by the same group of research workers.[11]

Another method of treating cottonseed consists of pressing it first until a cake is obtained containing about 10% of oil, followed by solvent extraction of this cake. Pons *et al.*[12] studied the relation between processing conditions and the chemical characteristics of cottonseed meals and oils produced by the combined method of prepressing/solvent extraction. They found that cooking conditions were the major factor influencing the distribution of the gossypol between the meal and oil. Reduction in free gossypol during cooking was due to binding with meal components, while that occurring during prepressing and solvent extraction resulted mainly from removal of gossypol in the oil. Prepressed oils gave lower refinining losses and lower refined colour than did the solvent-extracted oils. Many of the meals investigated showed good protein quality. The nutritional value of prepressed/solvent-extracted meals was investigated by Chang *et al.*[13] An interesting and useful nomograph for determining extraction efficiency was worked out by Graci[14] and should be of great practical use.

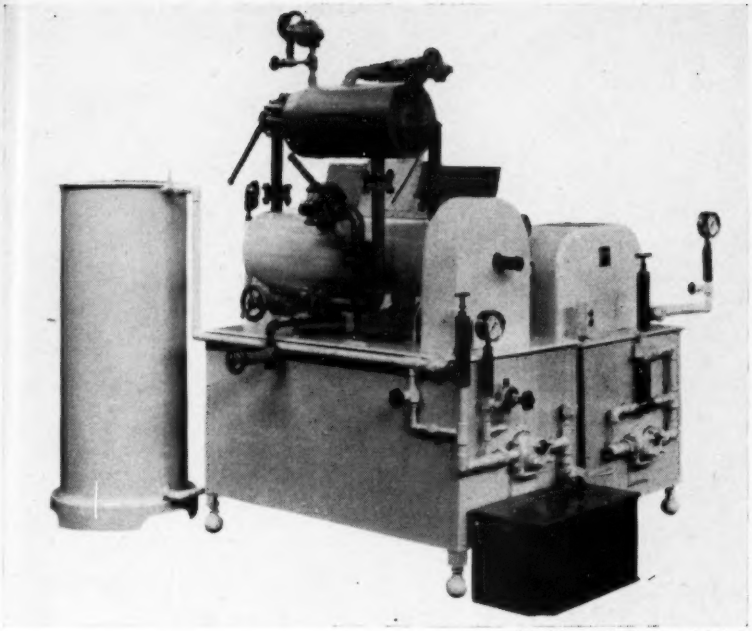
A number of continuous extraction plants are now in use; horizontal extractors are finding greater favour. One of the latest of these is a unit engineered by Miag GmbH in Germany. The extractor consists of a horizontal casing inside which buckets travel in the manner of an endless chain. The advantage of this extractor is that all buckets at any point of the circuit are used for extraction, and there are no buckets that are idling. Extraction is counter-current. The buckets are somewhat similar to those of the well-known Bollmann-type extractor.

Fish oils and their production

Some commercially important fish oils were recently discussed and literature about them brought up to date by Kaufmann and Thieme.[15] They tabulate characteristics and the fatty acid composition of the depot fats of the herring, sardine, pilchard, Japanese sardine and menhaden.

The composition of liver fats of sharks (*Galeocerdo tigrinus*), both of a mature animal and an embryo, was studied by Pathak and Suwal.[16] They found that, in keeping with the composition of liver fats of *Elasmobranch* fish, the mature shark liver fat contains 43.3% saturated and 56.7% unsaturated fatty acids. The embryo shark liver fat contains 39.1% saturated and 60.9% unsaturated acids. Palmitic acid was about 25% in both fats. Possible reasons for the different compositions of these two fats are discussed.

Einarsson *et al.*[17] developed a process for removing oil from fatty fish meal which does not cause great loss of stickwater soluble nutrients, which is a great disadvantage of the traditional wet-pressing method. Their method does not involve costly stickwater evaporation. The process described consists of drying the meal to a mois-



[A. Johnson & Co. (London) Ltd.

Continuous production of shortenings or cooking fats: the 'Votator' apparatus.

ture content of 5 to 9%, followed by pressing until about 6% oil is left in the meal. At present the process is only on the laboratory scale. A number of different fish meals were tested. Based upon measurements on turbot meal, the authors developed an empirical equation which permits the prediction of press efficiency in removing the oil. The possibility of using the solvent-extraction method on fish offal was recently discussed by Arnold and Arvidson.[18] These authors did research on the laboratory- as well as on the pilot-plant scale. The use of wetting agents, although promising in the laboratory, does not appear to be of much value for pilot-plant operation. A higher percentage of oil is removed by trichloro-ethylene under a given set of extracting conditions than with hexane. The mechanism of extraction is believed to be one of surface washing for short extractions and, for longer extractions, this washing process is supplemented by diffusion.

Food fats

The ever-increasing demand for edible fats, coupled with the necessity to produce them at the lowest possible prices, exerts a strong influence on processing techniques. Highest efficiency and lowest processing costs, resulting in products of highest quality, are the constant watchwords of the industry. One of the most important steps in transforming a crude oil into an edible fat is refining.

Some further data on the De Laval pressure system of centrifugal refining were published by Sullivan,[19] who confirms that ' increased efficiency should be the keynote of any refining system.' Comparing the continuous-pressure process with the conventional type of open centrifugal separator used for degumming of soya-bean oil, it was found that with the former there is a gain of 0.58 lb. of oil per 100 lb. of crude oil degummed. In the same article the pressure soda ash refining process and the new ammonia refining method are also described.

Refining losses can be substantially reduced, according to an American patent,[20] by adding 0.1 to 0.4% of phosphoric acid to the oil.

Studying the effect that moisture has during adsorbtion on the colour of the bleached oil, Rich[21] treated tallows at 160°F. under 7 mm. of mercury pressure for 30 min. The bleached oil was filtered. Both activated and natural clay adsorbents were used in the experiments. The test confirmed that, if 1% of water was present, a markedly better bleached oil was obtained than if no water was used.

The cakes retained on the filter presses used in bleaching operations contain a fair percentage of oil, usually between 30 and 50. To remove this oil the cake is steamed, but a considerable proportion of the oil cannot be removed by this method. Durkee[22] suggests treating the steamed press-cake with an aqueous solution of sodium silicate to obtain a better recovery of adsorbed oil.

A patent on the fractionation of fatty acid glycerides was granted to Bradley *et al.*[23] According to this, monoglycerides of soya-bean oil fatty acids are separated into a fraction *A* having a relatively low iodine number, and a fraction *B* having a relatively high iodine number. The crude monoglycerides are mixed with a methanol solution of urea and maintained at 10 to 45°C. for a while. Fraction *A* forms a crystalline urea complex which may be separated from the soluble fraction *B*.

Progress has also been made in the manufacture of margarine and shortenings as well as of some special edible products like acetin fats and rearranged lard. Continuous margarine production by the *Votator* or similar totally enclosed continuous plant is fast ousting the older type of margarine-producing equipment. A. Johnson & Co. (London) Ltd. are now manufacturing under licence from the Girdler Co., U.S.A. the *Votator* apparatus, which is finding wide applications in the U.K. and also abroad. The production of plastic food-fats made from vegetable oils by means of a laboratory *Votator* apparatus was reported on by Lancaster *et al.*[24]

Much attention is now being given to special food fats which remain spreadable at household refrigerator temperatures yet do not soften too much in the tropics. In other words, the product must have a wide plastic range. Hellman *et al.*[25] studied the effect of tempering on consistency changes in global spreads, *i.e.* plastic mixtures of saturated monoglycerides and oils. Physical studies led to the conclusion that consistency changes are a consequence of the recrystallisation of solid components. Softening occurring during the initial stages of tempering resulted from (*a*) weakening of aggregate structure present in an untempered spread and (*b*) recrystallisation of solids into more perfectly ordered and sharply defined crystals. Hardening after prolonged tempering resulted from further recrystallisation of solids into needle- and plate-like forms. Hellman *et al.*[26] used an analytical ultracentrifuge for separating plastic spreads into liquid and solid phases; the proportions of each phase were determined. Accurate results were extremely difficult to obtain because the solids phase consisted of approximately one-half liquid oil.

However, by centrifuging the plastic spread with a layer of aqueous alcohol of a density intermediate between the oil and the solids, the solids phase was separated more nearly oil-free. The solids phase was, however, still not sufficiently pure to permit a chemical characterisation representative of the solid component.

Another group of products with a wide plastic range, which have recently attracted much attention, are the acetin fats. Gros and Feuge[27] discussed the effect acetoglycerides have on consistency of a product.

A new type of shortening with a good plastic range and with excellent creaming powers is made by molecular rearrangement of lard. Hoerr and Waugh[28] reported recently on some physical characteristics of this high-grade edible product.

Fat chemicals

Amongst the biggest non-food users of fats are the soap and the paint industries. However, since the introduction of economical fat splitting and fractionation methods, ever-increasing quantities of fatty acids are produced. Some of their uses are in industries where even a few years ago their application was not even considered. The acids are used either as such or in a modified form. So many new derivatives of fatty acids are now being produced that it became necessary to coin a new name for them: 'fat chemicals'—analogous with the expression 'petrochemicals' for products derived from petroleum. A typical application of fat chemicals is in the textile industry. Pacifico and Griers[29] estimate that in the U.S.A. some 33 million lb. of surfactants are used in the textile industry, of which roughly two-thirds are fat, respectively fatty acids derivatives. These include anionics such as fatty alkyl sulphates and sulphonated amides, nonionics such as fatty alcohol ethers and alkylol amides, and cationics. The latter are the smallest of the three groups, accounting for 4 million lb. only. However, considering that it is only a few years since cationics entered the market in a competitive manner, this figure seems to indicate an extremely good reception of cationics by the textile industry.

Schwitzer[30] treated the nitrogen type of cationic fatty acid derivatives. Pure fatty acids are reacted in the presence of a catalyst with ammonia. Conditions are arranged in a way that nitriles result directly. Schematically the following separate steps of this reaction can be envisaged:

$$\underset{\text{fatty acid}}{R.COOH} + NH_3 \longrightarrow \underset{\text{soap}}{R.COONH_4}$$

$$R.COONH_4 \xrightarrow{\text{heat}} \underset{\text{amide}}{R.CO.NH_2} + H_2O$$

$$R.CO.NH_2 \xrightarrow[\text{catalyst}]{\text{heat}} \underset{\text{nitrile}}{R-C\equiv N} + H_2O$$

The resulting nitrile can be hydrogenated to yield a primary RNH_2, or a secondary R_2NH amine. These amines are highly hydrophobic chemicals and substantive to many materials. They react with acids such as hydrochloric or acetic to give water-soluble salts. Amines are also the starting material for quaternaries, amidoximes, hydrazides, imidazolines and many other compounds. The nitrogen derivatives of the fatty acids are finding divers uses such as for mineral flotation, pigment dispersion, rubber latex foaming, road making, waterproofing, rendering plastics and textiles antistatic, etc.

Books

It will be readily understood that in a short review of this type only a small selection of the many papers and patents published during a year can be given. It therefore appears most desirable to include some of the books published. Of these, Eckey's[31] takes pride of place. It is the most complete review (836 pages) ever written on all aspects of vegetable-oil sources and it incorporates an excellent summary of processing techniques. Another work of importance is Andersen's 'Margarine,'[32] because it is the first monograph on the subject for nearly a quarter of a century. Unfortunately some of the sections of the book are now a little out of date.

Readers of the first volume of Deuel's 'The Lipids' are not likely to be disappointed with the second volume[33] which has now appeared. Another book on lipids is a brilliant, concise essay by Lovern.[34]

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary letter or synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

In addition, the Editors and Publishers of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. A synopsis with chapter headings should be sent in the first instance to the Book Production Manager, at the above address.

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A Short Cut to the Determination of VAPOUR-LIQUID EQUILIBRIA for Partially Miscible Binary Systems

By O. P. Kharbanda, M.SC., D.CH.E.

In fractional distillation, the problem of calculating the equilibrium between the liquid and vapour phases of the mixture is one that often hinders the designer. In this article our contributor presents a short cut to obtaining the necessary data where binary mixtures of partially miscible liquids are concerned. He explains how calculations are made, starting from three fairly easily obtained physical values, and includes a practical illustration of the use of this method.

THE experimental determination of vapour-liquid equilibria is often beset with many practical difficulties and is, in addition, rather time-consuming. Also, there is a considerable doubt about the accuracy of a large amount of published experimental data. A great majority of the methods are based on the distillation principle and this assumes that the vapour from a boiling liquid is in equilibrium with it. The validity of this assumption is very doubtful[1] and it is not uncommon for different workers, using essentially similar techniques, to get results differing by as much as $\pm 10\%$ for the same system. For these reasons, any method for predicting the vapour-liquid equilibrium data from other more readily available physical data should prove extremely useful. The accuracy of the final results will naturally depend on the accuracy of the data employed and should, in most cases, be suitable for use in design purposes.

The present treatment is limited to partially miscible systems for which the experimental difficulties are even greater because of the presence of more than one phase in the boiling liquid mixture as well as in the condensate. Partially miscible systems form a very important group for fractional distillation. The vapour-liquid equilibria for such systems are very abnormal and, by properly combining distillation and decantation, otherwise difficult separations can easily be accomplished.

Fig. 1 shows the typical temperature-composition curves for a normal system and a partially miscible system. The corresponding vapour-liquid equilibrium curves are shown in Fig. 2. In the case of the partially miscible system, the temperature as well as the equilibrium vapour composition remains constant over the entire range of immiscibility in the liquid phase. This can readily be understood by examination of the phase rule: $P + F = C + 2$, where P = No. of phases, F = No. of degrees of freedom and C = No. of components.

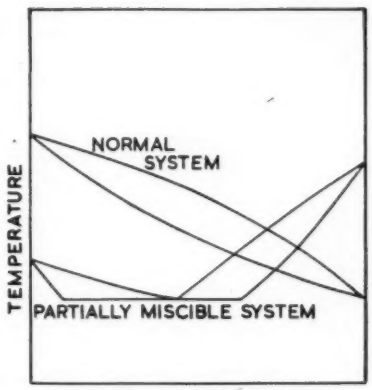

Fig. 1. Typical temperature-composition curves.

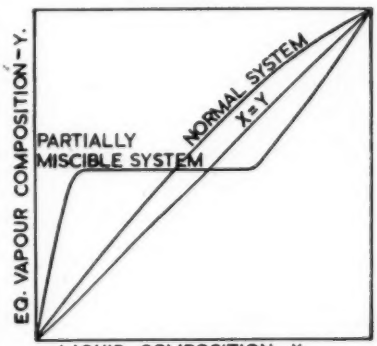

Fig. 2. Typical vapour-liquid equilibrium curve.

In the case of partially miscible binary systems, for the immiscible region, $C = 2$, $P = 3$ (two liquid phases and one vapour phase) and, therefore, $F = 1$, which means that one only of the two variables, temperature and pressure, is sufficient to define the system completely. At constant pressure, therefore, for the entire region of immiscibility, the temperature and hence the equilibrium vapour composition remain constant.

The method outlined here for the calculation of vapour-liquid equilibrium data requires a knowledge of the following physical data:

(i) Mutual solubility of the two components at the desired temperature.
(ii) Vapour pressure of the pure components.
(iii) Composition and boiling point of the azeotrope.

Of these, the vapour pressure data for the pure components are generally readily available; the data relating to the azeotrope, if unknown, can, in certain cases, be estimated[1] from generalised correlations; the mutual solubility data can generally be determined, without much difficulty, in the laboratory.

Development of the method

If the liquid as well as the gaseous phases can be assumed to be ideal, the partial pressure of a pure component can be expressed by the two equations:

Ideal solution (Raoult's) Law

$$p_1 = P_1 X_1 \quad \ldots\ldots\ldots\ldots \quad (1)$$

Ideal gas law

$$p_1 = PY_1 \quad \ldots\ldots\ldots\ldots \quad (2)$$

Combining equations (1) and (2):

$$PY_1 = P_1 X_1 \quad \ldots\ldots\ldots \quad (3)$$

where p = partial pressure of the pure component; P = total pressure; P_1 = vapour pressure of the pure com-

ponent; X = composition of the liquid, mole fraction; Y = composition of the equilibrium vapour, mole fraction; and subscript $_1$ = more volatile component.

For most cases of normal atmospheric distillation, the assumption that the gas behaves ideally is a fair approximation. The assumption of ideal solution behaviour, however, is seldom justified, except when the components belong to a homologous series. The deviations from ideal solution law are conveniently expressed as a multiplying factor, γ, known as the activity coefficient.

$$PY_1 = \gamma_1 P_1 X_1 \quad \ldots\ldots\ldots \quad (4)$$

$$PY_2 = \gamma_2 P_2 X_2 \quad \ldots\ldots\ldots \quad (5)$$

At the azeotropic composition, the liquid and vapour compositions become identical and the activity coefficients are simply the ratio of total pressure to the vapour pressure of the pure component.

$$\gamma_1 = P/P_1 \quad \ldots\ldots\ldots\ldots \quad (6)$$

$$\gamma_2 = P/P_2 \quad \ldots\ldots\ldots\ldots \quad (7)$$

In the absence of any experimental data other than vapour pressure of the pure components these equations can be used to get an order of magnitude for the deviation factor and thence the vapour-liquid equilibria can be calculated. These equations, however, cannot be used[2] when one of the components is concentrated in the azeotrope and seems to fail completely for the case of partially miscible systems.

The activity coefficient is unity (*i.e.* Raoult's law applies) for the pure component—this is conveniently expressed by the statement, 'Raoult's law applies to the solvent.' The value of the activity coefficient departs from unity as the concentration of the component decreases. The fundamental relationship between activity coefficient and concentration for a binary system is given by the Gibbs-Duhem equation:[3]

$$X_1\left(\frac{\delta \ln \gamma_1}{X_1}\right)_{T,P} = X_2\left(\frac{\delta \ln \gamma_2}{X_2}\right)_{T,P} \quad (8)$$

This equation is strictly valid only for a homogeneous liquid phase. It has been shown[4] to apply also when more than one liquid phase is present, provided the overall mole fraction is used for the concentration term. Equation (8) is rigorous; however, its use is limited since, in practice, either the temperature or the pressure does vary. Moreover, its form does not permit of an easy practical solution. Many approximate but useful solutions of this fundamental equation have been

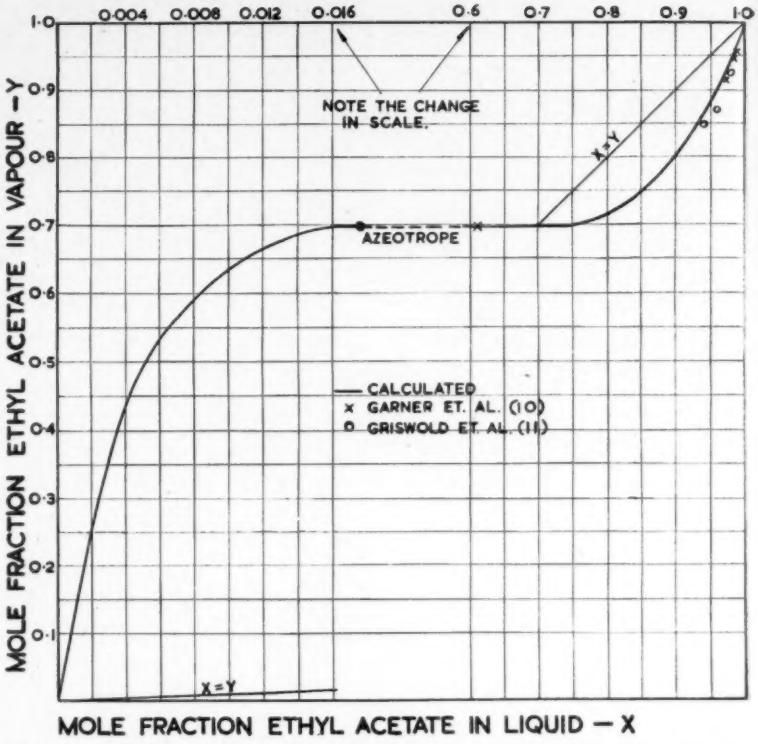

Fig. 3. Comparison of calculated and experimental vapour-liquid equilibrium data for the system ethyl acetate-water at P = 760 mm.

reported in the literature and one of the most convenient for practical calculation is that due to Van Laar:[3]

$$\log \gamma_1 = \frac{A_{1-2}}{\left(1 + \frac{A_{1-2}}{A_{2-1}}\frac{X_1}{X_2}\right)^2} \quad \ldots\ldots \quad (9)$$

$$\log \gamma_2 = \frac{A_{2-1}}{\left(1 + \frac{A_{2-1}}{A_{1-2}}\frac{X_2}{X_1}\right)^2} \quad \ldots\ldots \quad (10)$$

where A_{1-2} and A_{2-1} are constants characteristic of the binary system.

In the case of a partially miscible system at equilibrium, the activities of each component in both phases (activity being defined as the product of activity coefficient and concentration) must be equal,

$$a_1 = \gamma_1 X_1 = \overline{\gamma}_1 \overline{X}_1$$

or

$$\frac{\gamma_1}{\overline{\gamma}_1} = \frac{\overline{X}_1}{X_1} \quad \ldots\ldots\ldots\ldots \quad (11)$$

and similarly for the second component,

$$\frac{\gamma_2}{\overline{\gamma}_2} = \frac{\overline{X}_2}{X_2} \quad \ldots\ldots\ldots\ldots \quad (12)$$

It has been shown[3] that combination of equations (11) and (12) with the Van Laar equations (9) and (10) leads to:

$$\frac{A_{1-2}}{A_{2-1}} = \frac{\left(\frac{X_1}{X_2} + \frac{\overline{X}_1}{\overline{X}_2}\right)\left(\frac{\log \overline{X}_1/X_1}{\log X_2/\overline{X}_2}\right) + 2}{\frac{X_1}{X_2} + \frac{\overline{X}_1}{\overline{X}_2} - \frac{2X_1\,\overline{X}_1 \log (\overline{X}_1/X_1)}{X_2\,\overline{X}_2 \log (X_2/\overline{X}_2)}} \quad \ldots\ldots\ldots \quad (13)^*$$

$$A_{1-2} = \frac{\log \frac{\overline{X}_1}{X_1}}{\frac{1}{\left(1 + \frac{A_{1-2}}{A_{2-1}}\frac{X_1}{X_2}\right)^2} - \frac{1}{\left(1 + \frac{A_{1-2}}{A_{2-1}}\frac{\overline{X}_1}{\overline{X}_2}\right)^2}} \quad \ldots\ldots\ldots \quad (14)$$

When the mutual solubility data for a particular system are known at the temperature in question, the Van

*Note misprint in this equation on page 534 of Ref. [2]. A plus (+) sign is missing between $\frac{X_1}{X_2}$ and $\frac{\overline{X}_1}{\overline{X}_2}$ in the denominator.

Table 1. Comparison of Calculated and Experimental Values of Van Laar constants

System	X_1	$\overline{X}_2$	Ref.	Calculated		Experimental		Ref.
				A_{1-2}	A_{2-1}	A_{1-2}	A_{2-1}	
1. Bromine ... / Water	0.0040	≈0*	7	2.43	*	2.53	*	6
1. n-Butyl acetate / 2. Water	0.0016	0.0250	7	2.82	1.64	2.77	1.61	8
1. n-Butyl alcohol / 2. Water	0.0200	0.546	9	1.68	0.46	1.70	0.55	9
1. Ethyl acetate ... / 2. Water	0.0160	0.233	10	1.83	0.81	1.68 1.88	0.92 0.82	10 11
1. Methyl ethyl ketone ... / 2. Water	0.0450	0.385	7	1.46	0.65	1.33	0.68	6
1. Methyl isobutyl ketone ... / 2. Water	0.0024	0.093	12, 13	2.60	1.08	2.57	1.60	8

*Data not available

Table 2. Vapour-Liquid Equilibrium Data for the System Ethyl Acetate[1]-Water[2]

($A_{1-2} = 1.83$; $A_{2-1} = 0.81$)

Dilute acetate region

X_1	X_2	$\log \gamma_1 = \frac{A_{1-2}}{\left(1 + \frac{A_{1-2}X_1}{A_{2-1}X_2}\right)^2}$	γ_1	P_1	$Y_1 = \frac{\gamma_1 P_1 X_1}{P}$
0.000	1.000	1.83	67.5	1600	0.000
0.001	0.999	1.83	67.5	1510	0.134
0.005	0.995	1.79	61.6	1230	0.499
0.010	0.990	1.75	56.3	880	0.652
0.012	0.988	1.73	53.8	780	0.662

Concentrated acetate region

X_1	X_2	$\log \gamma_2 = \frac{A_{2-1}}{\left(1 + \frac{A_{2-1}X_2}{A_{1-2}X_1}\right)^2}$	γ_2	P_2	$Y_1 = 1 - \frac{\gamma_2 P_2 X_2}{P}$
0.767	0.233	0.630	4.27	232	0.696
0.800	0.200	0.655	4.52	240	0.714
0.850	0.150	0.695	4.95	260	0.746
0.900	0.100	0.735	5.45	275	0.802
0.950	0.050	0.772	5.94	290	0.887
0.980	0.020	0.794	6.24	300	0.951
1.000	0.000	0.810	6.45	305	1.000

[1]Total pressure, $P = 760$ mm.

[2]Vapour pressures of the pure components are taken from Ref. [2] on the basis of an assumed linear temperature distribution between the known limiting values (normal boiling points being: water, 100°C.; azeotrope, 70.4°C.; ethyl acetate, 77.1°C.). This assumption is not strictly valid, but any other distribution will not affect the final results significantly.

Laar constants, A_{1-2} and A_{2-1}, can be calculated by means of equations (13) and (14). However, these equations are rather laborious to solve and in a later publication a convenient graphical solution is presented.[5] A large number of numerical examples were solved and plotted in a convenient manner. This graph is also reproduced in the 'Chemical Engineer's Handbook.'[2]

Calculation procedure

From the known values of mutual solubility, X_1, $\overline{X}_1$ and X_2, $\overline{X}_2$, the Van Laar constants can be estimated from the graph in the handbook.[2] Using values of these constants in equations (9) and (10), the activity coefficients can be calculated as a function of composition. The equilibrium data are then calculated by use of equations (4) or (5) on the basis of an assumed temperature distribution. Such calculation needs only be done for the miscible range of composition, since the equilibrium vapour composition remains constant for the entire range of immiscibility.

Table 1 shows a comparison of the experimental and calculated values of Van Laar's constants. In general the agreement between the two seems quite satisfactory. However, for the case of methyl isobutyl ketone-water system the calculated value (= 1.08) of the constant A_{2-1} differs considerably from the experimental value (= 1.60). This constant relates to the high ketone concentration region and the discrepancy may possibly be due to the practical difficulties in analysis of such samples.

Illustrated example. The use of the calculation procedure described is illustrated for the system, ethyl acetate-water:

Solubility of ethyl acetate in water, $X_1 = 0.016$

Solubility of water in ethyl acetate, $\overline{X}_2 = 0.233$

$$X_1 = 0.016, \frac{\overline{X}_2}{X_1} = \frac{0.233}{0.016} = 14.5$$

From Fig. 5, page 533 in Ref. [2], $A_{1-2} = 1.83$.

Similarly for, $\overline{X}_2 = 0.233$, $\frac{X_1}{\overline{X}_2} = 0.07$.

$$A_{2-1} = 0.81$$

The calculation of vapour-liquid equilibrium data using these constants is shown in Table 2.

The vapour-liquid equilibrium data obtained are plotted in Fig. 3, a horizontal straight line being drawn at $Y = 0.697$ for the entire immiscible range from $X_1 = 0.016$ to $\overline{X}_1 = 0.767$. The experimental results of two previous investigations relating to this system are also shown in Fig. 3. The calculated and the experimental results agree reasonably well.

NOMENCLATURE

a	=	Activity = γX.
A	=	Van Laar's constant.
p	=	Partial pressure.
P	=	Total pressure.
P_1, P_2	=	Vapour pressures.
X	=	Concentration in liquid, mole fraction.
$\overline{X}$	=	Concentration in the other liquid phase, mole fraction.
Y	=	Concentration in vapour, mole fraction.
1	=	Component 1.
γ	=	Activity coefficient.

Acknowledgment

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(*References on page* 250)

Stanlow's New Desulphurisation Unit

'TRICKLE' TECHNIQUE CUTS CAPITAL AND OPERATING COSTS

THE first of its kind to be built in the world and costing £1 million to erect, the 'hydrodesulphuriser,' a plant which removes sulphur from petroleum products by the 'trickle' technique, has recently come into operation at Shell's Stanlow oil refinery in Cheshire. The new plant will increase the supply of high-quality fuels for diesel engines and farm tractors and will also make a certain amount of a 100-octane motor spirit component. The 'trickle' technique is so called because the oil to be desulphurised is contacted with hydrogen and made to trickle over a special catalyst. The hydrogen converts the sulphur into hydrogen sulphide which is separated from the oil and is then itself converted to pure elementary sulphur. Here are some notes on the unit.

Development of the process

Extensive laboratory and pilot-plant investigations, aiming at the development of a low-cost hydrodesulphurisation process, have been carried out in the Royal Dutch/Shell Group's research laboratories at Amsterdam during recent years. An analysis of the various items governing the total cost of hydrodesulphurisation of oil distillates shows that cost is appreciably reduced when the amount of cycle gas is decreased. However, reduction of the amount of cycle gas considerably below the conventional level will result in operating conditions under which most of the feed is no longer vaporised, but remains in the liquid state.

Extensive research showed that a high degree of desulphurisation with a relatively small amount of hydrogen gas can be obtained using a procedure in which the oil is allowed to trickle over a solid catalyst in a hydrogen atmosphere. It was found that, under these low hydrogen recycle conditions, the catalyst activity was not impaired at all. Moreover, it could be shown that this technique can be applied to a variety of base materials and with catalysts of different nature.

The low hydrogen recycle rates which are possible when applying the 'trickle' technique involve a significant saving in operating and capital cost, not only because of the reduced capacity and power consumption of the hydrogen recycle compressors, but also because of a reduction in the heat-transfer surface area required, since a considerably smaller amount of heat has to be transferred through feed/products heat exchange, whereas also the fired preheater can be relatively small. The cobalt-molybdenum-alumina catalyst which is used in this process was developed especially for high selectivity, *i.e.* very little hydrogenation of aromatics even at a high degree of sulphur removal.

The first commercial hydrodesulphuriser applying the 'trickle' technique and erected at the Stanlow refinery of Shell Refining & Marketing Co. Ltd. was started up recently. Although able to desulphurise quite a variety of feedstocks, the design was especially directed towards desulphurisation of light cat-cracked cycle oil. This feedstock has been processed so far during the initial stage of operation. A comparison of the commercial-scale operational results with the design values has shown that the results are very satisfactory, being better than design. During the first weeks of operation, runs were carried out at different throughputs; 90% or more desulphurisation has been obtained for feed rates of 5,000 and 7,000 bbl./day.

Design features

The hydrogen to be consumed during the hydrodesulphurisation reactions, and the hydrogen-rich recycle gas used for catalyst protection, are compressed to the operating pressure with separate compressors. The compressed hydrogen-rich gases are combined with the major part of the charge oil and introduced into feed-product heat exchangers and reactor charge heater, and heated to reactor inlet temperature. The remaining part of the charge oil is fed cold to the reactor to dissipate the heat of reaction. The reactor products, consisting of hydrogen, light hydrocarbons, partly vaporised desulphurised cycle oil and hydrogen sulphide, exchange heat with the reactor feed, are cooled down further and are finally introduced into the high-pressure separator where a hydrogen-rich gas is separated. This gas is recycled and, if necessary, partly bled into the refinery fuel gas system, after being scrubbed with diethanolamine to remove the hydrogen sulphide. The H.P. separator liquid is flashed in the L.P. separator and introduced into the fractionation section.

In this section, consisting of a main fractionator and two side strippers, the desulphurised product is split into three fractions, whereas the dissolved light hydrocarbons and hydrogen sulphide are removed overhead. The overhead gases are combined with the gases flashed off in the low-pressure separator. When processing light cat-cracked cycle oil the reactor products are split into a highly aromatic heavy gasoline fraction, a 220 to 260°C. fraction and as a main product a bottom

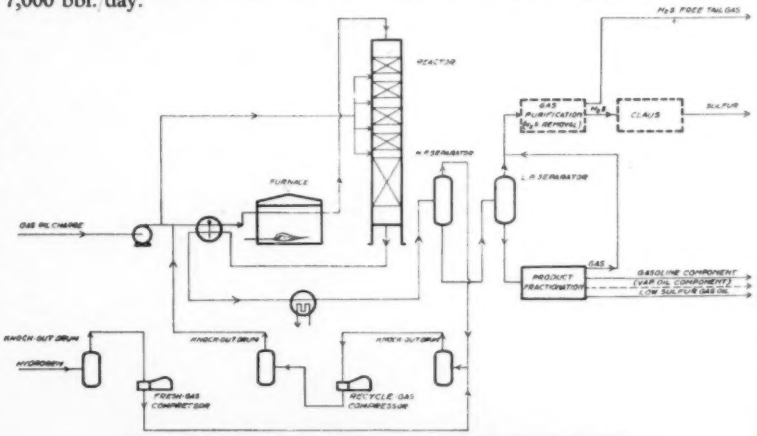

Fig. 2. Simplified flow scheme of the hydrodesulphuriser.

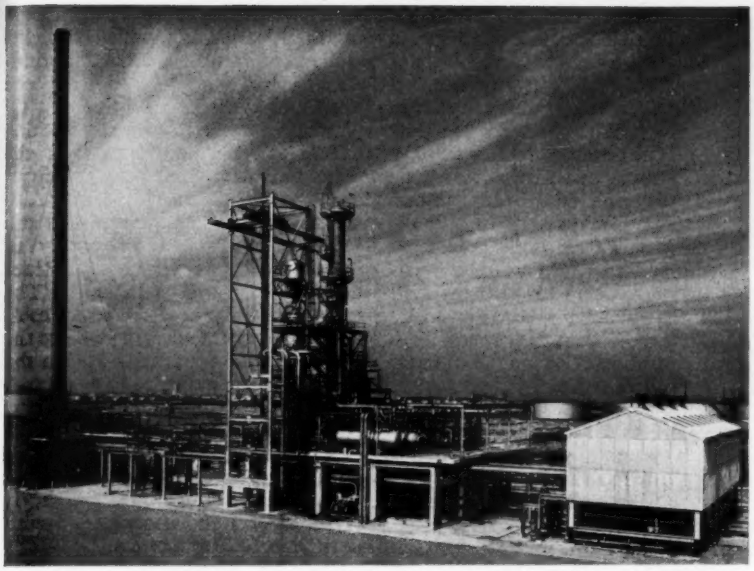

Fig. 1. A general view of the new hydrodesulphurisation plant at Stanlow.

fraction boiling above 260°C. Reboiler heat for the strippers is supplied by a slip stream taken from the fractionator bottom stream. A reboiler furnace supplies heat to the main column.

The reactor contains in all nearly 25 metric tons of catalyst divided over six beds. A 2-ft. layer of ceramic balls is added on top of the upper catalyst bed as a scale catcher. At a throughput of 5,500 bbl./day the space velocity amounted to 1.27 vol./vol.hr. and at 7,000 bbl./day to 1.59 vol./vol.hr.

About 20% of the charge oil has to be used as cooling oil to limit the reactor outlet temperature to the desired level.

Operational results

The 260°C.+ fraction contained only 0.3% wt. sulphur. The sulphur contents of the other fractions were lower than anticipated. The product distribution was as expected nearly 70% on feed boiling >260°C. The gasoline had a clear research octane number of over 100 and amounted to 5% wt. on feed. All products met the specifications set forward for the various streams by the product department.

Temperature control of the various reactor beds by means of cold oil injected into the various mixing-redistributing trays proved to be excellent; no temperature run-aways were observed and the effect of injection of cooling oil could easily be traced by the temperature readings.

In conclusion it can be said that the operation of the first hydrodesulphuriser is quite satisfactory and even exceeds expectation. Over 90% sulphur removal has been obtained when processing light cat-cracked cycle oil at 7,000 bbl./day.

Begun about the middle of 1953 and almost entirely of British manufacture and materials, the hydrodesulphuriser adds further to the reputation of Stanlow as one of the most fully integrated oil refineries outside the United States. Already included in the facilities on the 2,000-acre refinery site are the first platformer in the U.K. and Europe, a cat-cracker, a modern chemical plant, a synthetic detergent plant and an iso-pentane unit for the production of an important constituent of aviation gasoline.

New Instruments and Controls

SOME CHEMICAL INDUSTRY AND ALLIED EXHIBITS AT THE B.I.I.E.

THE British Instrument Industries Exhibition is being held in London as we go to press and in this article we present a few brief impressions. **Automatic controls** are a prominent attraction and among the new exhibitors this year is Black Automatic Controls Ltd. This firm's display includes oil valves, gas valves, safety switch valves and pressure switches. The outstanding feature of the latter is the use of a small, neat micro-switch which, the makers state, is nevertheless capable of handling adequate control current. The pressure switches are of the diaphragm type, are available in various pressure ranges and provided with full adjustment.

Of a somewhat different character is the display of Hammel-Dahl diaphragm-operated valves, for automatic process control, by J. Blakeborough & Sons Ltd. The principal items include a large, cast-steel, double-seated globe valve with stainless-steel trim, from the standard B.3000 series; a butterfly valve, with continuously connected handwheel for alternative manual operation; and an angle valve in cast steel, with special seal-balanced *Holo* plug, giving the combined features of balanced control and tight shut-off. Amongst other valves shown are the barstock type, supplied either with solid plug or with spline plug for special accuracy in control of small flows; and examples showing the application of Dahl seal and bellows seal.

Turning to **electronic control apparatus,** we find Evershed & Vignoles Ltd. exhibiting a control desk incorporating their novel form of instrument presentation in which shadow-type indicators are arranged close together so that the pointer shadows form a continuous line. With a number of indicators so mounted, it is possible to show a continuous line from which the stability of the plant may be seen at a glance; any deviation from normal conditions is immediately apparent to the operator.

Honeywell-Brown Ltd. also exhibit electronic instrumentation, while those interested in **flow measurement and control** are able to inspect a pneumatic controller, a ratio controller, a pneumatic receiver with electronic integration, and an electronic inductance bridge receiver with integrator. The last mentioned is a circular chart instrument which will indicate, record, control and integrate flow measurement. The differential converter ex-

hibited is a mercury-less type of manometer operating on the pneumatic force-balance principle; the area-type meter varies an orifice area while maintaining the differential pressure at a fixed value. It was designed to meter viscous liquids such as hot tar.

Shown in operation on the stand of Foxboro-Yoxall Ltd. are the Model 50 series of *Consotrol* recorders and controllers, which are seen controlling the flow and level of a simulated process in which changes can be created to demonstrate the response of the instruments. Further exhibits include the *Stabiload* cylinder, illustrating systems of pneumatic loading, and a new temperature transmitter—a narrow-span, force-balance instrument with a number of uses

Elecontrol Ltd. exhibit three types of electronic **level control** units which are now available as single-stage units and, in addition, a standard double unit is produced which combines the functions of two single units and which may be used, for example, to give pump control or high- or low-level alarm. An especially sensitive model is for use with liquids of low conductivity. This company's range of probe fittings now includes a robust fitting designed for operation in pressurised vessels operating at reasonably high temperatures. The company are showing for the first time at this exhibition their new style of construction which is being applied generally to all except their smallest control units. This provides a withdrawable chassis which plugs into a deep-drawn steel case provided with a hinged lid.

On another stand, an item of particular interest to the chemical industry is a new electro-pneumatic transducer designed to receive small electrical signals direct from such sensing elements as thermocouples and giving a pneumatic output of 3 to 15 p.s.i. Another exhibit is equipment, now being manufactured in Britain, for the **measurement of viscosity** by means of ultrasonic oscillations. The exhibiting firm is Elliott Brothers (London) Ltd., whose stand makes a special feature of automation and whose exhibits range from the simplest of process control instruments on the one hand to the latest type of electronic digital computer on the other.

A plug-in controller and M/P station, a new miniature pressure regulator, an improved valve positioner and additions to their pressure transmitter range were shown by Sunvic Controls Ltd. among their industrial process control instruments, while a leak detector exhibited on the same stand—a production tool—is of particular interest for those concerned with the detection of minute leaks in castings, etc., in large-scale production.

The instrumentation of a sulphur recovery plant and a working installation of 'simmering' control are featured by George Kent Ltd., while the oil industry section of the same stand includes a working model showing the comparison between the Dall tube, the Venturi tube and orifice fittings as differential producers for flow measurement. For the sugar industry there is a complete presentation of the instrumentation of a diffusion battery.

In many industrial processes it is necessary to perform repetition titrations which require the constant attention of a skilled laboratory assistant. It is to speed up this operation and to allow the use of unskilled labour that the Pye **automatic titrator** has been designed. Basically this instrument is an electrically operated two-speed burette tap controlled by a *p*H meter (or other device which may be in use) which indicates the end-point of a titration. The instrument is housed in a metal body, making it suitable for operation in chemical laboratories. The case is similar to that of the Pye universal *p*H meter, with which it will often be used. When controlled by a *p*H meter the end-point can be set to any *p*H value, and the makers of this instrument, W. G. Pye & Co. Ltd., state that the stability of this setting will be better than ± 0.1 *p*H units. The change over from fast to slow reagent flow can anticipate this end-point by up to 5 *p*H units.

An interesting electronic **metal detector** with industrial applications is shown by Cinema-Television Ltd., who state that this new equipment will detect the presence of any ferrous or non-ferrous metal in any non-metallic product, and will automatically eject it from the product or otherwise give an alarm. Dosimeters exhibited by the same company are personal pocket radiation monitors designed to indicate an integrated dose of either *x*- or gamma-ray radiation. A further exhibit on this stand is a flying-spot microscope designed to present on a television-type screen a picture originating from a microscope slide. The equipment combines the advantages of increased magnification with compatible resolution, variable contrast control and the ability to count and size particles automatically.

New **centrifuges** shown by Measuring & Scientific Equipment Ltd. include models with an integral windshield which enables high speeds despite the loading conditions. Of particular interest to scientists working in the low-temperature field is the display of five refrigerator centrifuges of various capacities and speeds. Also being exhibited are homogenisers and blenders which, with a variety of accessories, can deal with quantities of materials from 3 to 1,000 ml. The homogeniser also has facilities for cooling, an important advantage where the temperature rise inseparable from the mixing process has to be counteracted.

A **portable field sieve** is a new development being exhibited at the stand of Endecotts (Filters) Ltd. This sieve is supplied with interchangeable bottoms of any specified mesh, is 12-in. square, and can be used with or without Rooker receiving pan. The screens are held in place by quick-action clamps and can be quickly changed from one mesh to another. All of the screens can be clamped into the frame for carrying when not in use.

Vapour-Liquid Equilibria

(*Concluded from page* 247)

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Gas Council's research station

The Birmingham Research Station of the Gas Council will in future be known as the Midlands Research Station, as it is now accommodated in new laboratories at Wharf Lane, Solihull, Warwickshire.

The Production of Fresh Water from Salt or Brackish Water—Part 2

By J. Leicester, M.I.CHEM.E., A.I.MAR.E.
(*Royal Naval Scientific Service*)

This article, begun in our May issue, surveys the past, present and future trends of fresh water production and describes some recent Royal Naval experiences in this field. This second and concluding part contains some interesting information about a new feed-water treatment. Evaporator design in the future and demineralisation by ion exchange and electrodialysis are other subjects touched upon.

DURING the past 10 years several successful feed-water treatments have been developed—some for use over a wide range of operating conditions and for various designs of evaporating plant, and others specifically for a plant of particular design and set of operating conditions. It is the intention in the present article to describe only the treatment which has become the basis of the present *Admiralty Evaporator Compound*, now in use throughout H.M. Fleet and by many of the leading mercantile marine shipping companies.

It was decided at the commencement of this development that any successful treatment must conform to the following requirements:

(1) The treatment must be effective in controlling calcium carbonate, magnesium hydroxide and calcium sulphate deposits.
(2) The quantities of feed-water additive required must be small to reduce the weight and space for stowage of stock chemicals.
(3) The chemicals used must preferably be non-corrosive and essentially non-toxic in case carry-over should contaminate the distilled water.
(4) The chemicals used must be capable of easy mixing in cold or warm water.
(5) The treatment must be stable enough to permit a degree of under-dosing or over-dosing without any serious effect on the anti-scaling properties.

It has been found that the only treatment likely to fulfil these requirements is one involving the use of a powerful surface-active material which, in low concentrations, will considerably modify the normal crystal habit of the scale-forming materials, thereby causing the scale to become non-adherent and friable, and to break away from the heating surfaces during operation. *Belloid T.D.*, the sodium salt of di-naphthyl methane di-sulphonic acid, is the main scale-preventative constituent used in the present treatment. This material is a very powerful anionic dispersing agent for calcium and magnesium compounds. It is non-corrosive and also non-toxic. The effective dosage of this material is only 0.002% by weight on the sea-water feed, or about 6 oz. per 10 tons.

During the evaporation of brine in the presence of *Belloid T.D.* this surface-active material is adsorbed on to the surface of the precipitated crystal nuclei of the scale-forming material, thereby producing a particle with a pronounced negatively-charged surface and at the same time considerably modifying the habit of the normal crystal growth. Similarly, the *Belloid T.D.* is absorbed on the metal heating surface, giving it a negative charge. These small electrical surface charges on both scale particles and metal surfaces alike create a slight tendency for the particles to repel one another and to be repelled by the metal heating surface, and thus account for the typical brittle and non-adherent properties of scale deposition in the presence of *Belloid T.D.* Natural flexing and movement of the heating coils during operation, due to pressure or temperature changes, results in the break-away of pieces of friable scale. Extensive areas of the heating coils are thus maintained clean to bare metal which ensures a marked improvement in the efficiency of the evaporator. This break-away of scale is continuous and all that has to be done is to ensure a regular daily blow-down of the evaporator and take out the pieces of scale from the bottom of the shell. In addition to conditioning the scale within the evaporator, the powerful dispersing action of the *Belloid T.D.* is notable for its effect in maintaining clean auxiliaries. Instead of brine pump impellors, brine strainers, etc., frequently scaling up, it is found that these also remain clean for lengthy periods.

The second constituent of the *Admiralty Evaporator Compound* is the sodium salt of ethylenediamine tetra-acetic acid, a non-corrosive and non-toxic sequestering agent known by the trade name of *Sequestrol*. The use of such chemicals in the field of water treatment is quite common. For instance, the complex phosphates such as hexametaphosphate or tripolyphosphate are often used for complexing calcium or magnesium ions. In one particular application, the 'threshold treatment,' the addition of as low a proportion as 5 p.p.m. of sodium hexametaphosphate (*Calgon*) will hold in solution many times its own weight of calcium and magnesium ions.

However, in the evaporator system it is not possible to use the complex phosphates due to their decomposition and reversion to the basic di-sodium phosphates at the temperature of operation. Organic sequestering materials such as the above-mentioned *Sequestrol*, however, are stable in brine up to temperatures as high as 300°F. The effective dosage is again 0.002% by weight on the sea-water feed. In addition to the beneficial sequestration of a certain proportion of the calcium and magnesium present in the brine (thereby reducing the total weight of scale-forming material), the *Sequestrol* also takes up any free copper ions present in the brine that may have resulted from corrosion of the copper heating surface.

The presence of free copper ions in the brine has been found to have a profound effect on the degree of adherence of the scale to the metal surfaces. It has been observed that the initial scale layer appears to consist of a magnesium/copper complex and this is true even if the bulk of the

scale deposited later consists essentially of, say, calcium carbonate. It is the author's opinion that herein lies one of the reasons why the scale normally adheres so firmly to the metal surface, making it often necessary to use mechanical force to remove this initial scale layer. If this adherent bond between scale and metal could be broken it is obvious that scale would break away easily, and there would then be a possibility that this break away could occur during the normal operation of the evaporator due to the natural flexing of the heating coils.

The use of *Sequestrol*, with its high efficiency for complexing metal ions, provides an ideal means of holding the copper in solution as a complex so that it is not available to combine with the magnesium. Examination of numerous scale deposits formed from brine treated with a mixture of *Belloid T.D.* and *Sequestrol* has shown that there is no adherent bond between the inner scale layer and the metal heating surface in such cases. Instead, the metal surface is bright and clean and the surface of the inner scale layer smooth and free from any traces of corrosion deposit, an ideal condition for the promotion of scale break-away.

Typical operating results show that evaporators can now be steamed for 4,000 hr. and over without stoppage for coil removal and cleaning. Fig. 4 shows a typical result obtained in the evaporators on board H.M.S. *Implacable*. With this treatment, the tendency is for the initial rate of scale formation to be about the same as without treatment, but after 500 hr. operation scale has commenced to break away freely, and from this point onwards a state of dynamic equilibrium is maintained where rate of formation of new scale equals rate of break away of old scale. Fig. 5 illustrates the same effect in terms of overall heat transfer against hours steamed, and emphasises the considerable gain in efficiency when using this treatment.

Finally, I would refer to a third ingredient, a non-toxic anti-foaming compound developed for the Admiralty by the Geigy Co. Ltd., which in the very near future will almost certainly be blended with the present *Admiralty Evaporator Compound*. The material is one of the polyethylene glycols which is capable of admixture with the previously mentioned chemicals to form a balanced anti-scaling/anti-foaming feed-water treatment. This chemical has very powerful properties and is effective in quantities as low as 0.0005% by weight on the sea-water

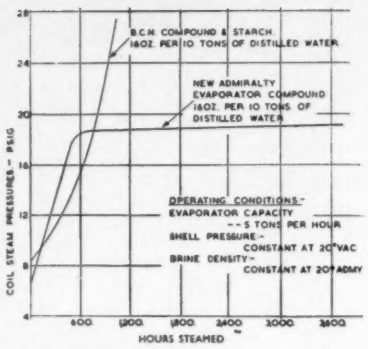


Fig.4. Typical operating results when using Admiralty Evaporator Compound.

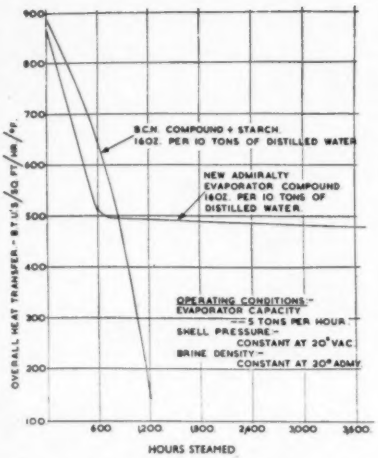


Fig. 5. Effect of scale formation on overall heat transfer.

feed. As previously mentioned, an evaporator handling brine, either untreated or treated with the anti-scaling compound, may have a stable foam layer on the surface of the brine of at least 18 in. in depth. Owing to the necessity of maintaining an adequate free volume between the surface of the brine/foam layer and the underside of the baffle to avoid entrainment and carry-over of salt droplets, it will be obvious that the surface of the foam cannot be allowed to rise much above the top of the heating coils. This in turn means that only about one-third to one-half of the heating coils are immersed in solid brine, the remainder being in a brine/vapour (foam) mixture. This foam will vary in density, and in the upper layer will be largely vapour. This means that the heat transfer from heating coil to brine becomes progressively lower as the vapour content of the foam increases and, in fact, the top two or three coils are transferring very little heat at all. The use of an anti-foam additive will, therefore, allow the evaporator to work with all heating surfaces immersed in solid boiling brine, and should result in a considerable increase in output and operating economy for any given size of plant.

Pilot-plant evaporator experiments quickly proved the value of this suggested treatment, and Fig. 6 illustrates the increased output of pure water that can be obtained when using this particular compound; an increase in output of some 50% over that obtained without the anti-foam addition is recorded. One other valuable effect observed during this work was the apparent synergistic effect of the mixture of the polyethylene glycol and *Admiralty Evaporator Compound* on the anti-scaling properties of the mixture. The typical scale break away previously described was found to be taking place much earlier, and the state of dynamic equilibrium was reached at a lower coil steam pressure with a consequent increase in the operating economy. This we believe is due to the surface-tension effect of the anti-foam influencing the size of the steam bubbles formed at the heating surface. Assuming the deposition of scale to commence at the interface of the steam bubble and heating surface, then rate and quantity of scale formed will be directly related to bubble size. When boiling sea water without anti-foam addition, the normal tendency is to form a large number of small steam bubbles, whereas in the presence of anti-foam, the changed surface tension influences the formation of a reduced number of large bubbles. Hence, use of the anti-foam reduces the rate and quantity of scale deposited per unit-area of heating surface.

Although full-scale proving trials of this anti-foam are still in progress, there has already been one very successful practical application of the new mixture; this has been in the evaporators on board the Royal Cruise liner, the S.S. *Gothic*. Here, just prior to the ship leaving this country, a serious emergency had arisen concerning the performance of the ship's two 40-ton/day evaporators. On trial it had been found that these two plants (originally rated on fresh water), when evaporating salt water, could not produce more than 10 tons/day each of pure water. Anything above this output caused heavy priming and salt contamination of the made water. During the period of the cruise it was necessary for the ship to produce fresh water from sea water for a period of

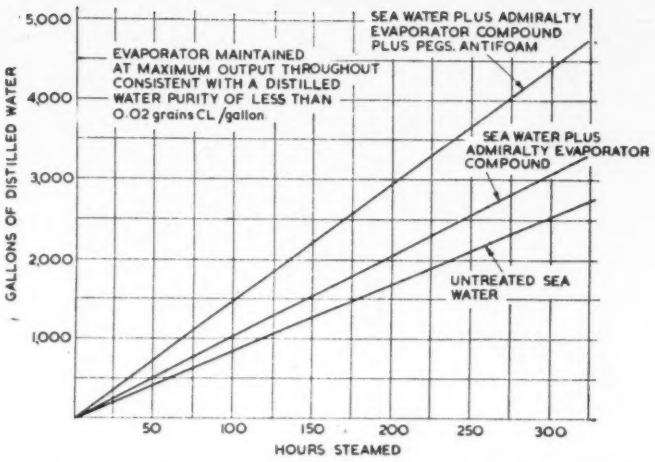


Fig. 6. Effect of the Pegs antifoam on distilled water output (pilot-plant experiments).

at least six weeks. The quantity required per day was some 40 tons of fresh water, so it is obvious why the original performance of the evaporators made the position so critical.

Mechanical modifications were immediately carried out under the direction of the Engineer-in-Chief of the Fleet's Department, being mainly an attempt to increase the height of the evaporator shell in an effort to reduce the carry-over of salt droplets into the baffle. This, as expected, produced an immediate improvement in the output of pure water, but it was still only possible to achieve an average output of 19 tons/day/evaporator, a total still slightly below the desired overall 40 tons/day, allowing no margin of safety for plant shut-down or reduced output due to scale formation.

In view of the remarkable success of the anti-foam trials, it was therefore decided to investigate the use of the new compound in these evaporators. The author spent two weeks on board the S.S. *Gothic* immediately prior to her departure, and a series of runs was carried out. The results achieved were outstanding and it was found possible to increase the average output to some 32 tons/day/evaporator. These trials continued for some 300 hr. and at their conclusion the evaporators were opened up and examined. It was found with considerable satisfaction that up to 70% of the heating surface was clean to bare metal and scale was cracking away freely from all areas. The condition of the coil surface was so good that cleaning was not necessary and the ship started her voyage without any further attention to either of the evaporators.

It is of interest to note the condition of these evaporators after several months' operation. A recent report from the chief engineer of the S.S. *Gothic* (despatched from New Zealand to her owners, the Shaw Saville Line) has fully confirmed the optimism in regard to this treatment. The ship had been steaming on one or other of the evaporators continuously since leaving Britain, and she was still getting enough fresh water from *one* evaporator to satisfy the needs of the ship's complement.*

Savings achieved by new feedwater treatment

The results of scientific achievement are not always easy to assess in terms of direct financial savings. However, in the case of the production of fresh water from sea water, a product is obtained which can be costed in terms of fuel oil burned to provide the primary heating steam for the evaporators. It is interesting, therefore, to balance expenditure on scientific effort against anticipated savings in the cost of fresh water resulting from the improved efficiency of the evaporating plant.

In the majority of existing modern design evaporating plant, the output with clean heating surfaces is sufficient to cover the ship's normal fresh water requirements. Scale formation, however, rapidly reduces the distilled water output and the plant has then to be forced in order to maintain water production. This results in a lowered operating efficiency and wastage of heat. Development of the latest anti-scaling/anti-foaming evaporator compound has increased the operating life of the evaporator five-fold and coil cleaning and changing has been eliminated during this period. As the continual break-away of scale leaves a high proportion of the heating surfaces clean to bare metal, the average overall efficiency has been increased by some 30% over that achieved when using the previous B.C.N./starch compound. On this basis the following savings emerge:

Cost of water produced—

- 18 shillings/ton prior to the present treatment;
- 12 shillings/ton with the new feed treatment.

Saving in fuel oil burned at the boilers—34 tons of fuel oil/1,000 tons of made water.

To be offset against the above savings will be the increased cost of the feed-water treatment at about 4d./ton of made water.

Now, assuming a total production of water throughout the fleet of 2 million tons of distilled water p.a., the cost of producing this prior to the present feed-water treatment would be roughly £1¾ million (inclusive of the cost of the old feed-water treatment at 0.2d./ton of made water). The cost of production with the present feed-water treatment would be about £1¼ million (inclusive of the cost of the present treatment at 4d./ton of made water). A net saving of some £500,000 p.a. is thus obtained.

The total cost of the research work over the past nine years (which has resulted in the development of this latest compound) amounts to £10,000 for salaries and, say, £5,000 spent on equipment, supplies of chemicals, etc. This represents a total of £15,000 to be offset against the estimated annual saving of £500,000.

Future design distilling plants

Apart from the established advantages of the new methods of feed-water treatment, steps are being taken to reduce the inherent inefficiency of the sea-water distilling plant.

The vapour compression type of distillation plant has been given some attention, along with the economics of this system of evaporation. It is sufficient here to stress the importance of this method of distillation and to emphasise the considerable reduction in the cost of fresh water produced. Extensive development programmes are in progress aimed at the use of these evaporators not only

*It has been reported that throughout a total of 1,900 hr. service the evaporators of S.S. *Gothic* have worked perfectly and are now producing 28 tons/day from each evaporator.

on board ship but also for land applications.

In particular, the electrical and diesel-driven vapour compression evaporator is likely to be of considerable value in any future ships that may be dependent on sources of propulsive power other than conventional steam-driven turbine machinery. Cost estimates have shown that, with a diesel engine-driven vapour compression plant, fresh water can be produced for as low as three to four shillings per ton, a big saving compared with the present best figure of 12s./ton. It should be noted that this type of evaporator still suffers from the inherent difficulty of scale formation on the heating surfaces, and present experimental work is directed towards the development of specific treatments for this design of evaporator.

The impact of this anti-scaling/anti-foaming compound on evaporator design may be considerable. In the past, evaporator designers and manufacturers have accepted the heavy penalty of loss in efficiency due to scale formation. When designing a plant for a given rated output they have had to allow for low heat-transfer values by providing a large heating surface area to enable the plant to produce its rated output with scaled surfaces. Similarly, with the effect of foaming, shell heights have been designed to afford an adequate margin of safety so as to prevent entrainment and carry over of salt droplets. With the new conception of cleaner and fully immersed heating surfaces without foam formation, it will now be possible to streamline the design of evaporating plant considerably. Coil areas for a given output of made water will be less and the free volume of the evaporator shell can be reduced if there is no danger of heavy foaming and carry over. This will result in the design and manufacture of smaller and lighter evaporator equipment with associated benefits to the layout of the engine-room machinery.

It is also essential to use as much low-pressure steam as possible (from which energy has already been extrated in the turbine) for evaporator heating, as this provides a large source of low-grade heat which is virtually cost free. Future conventional evaporator design is swinging rapidly towards this goal, but to achieve success the evaporator must operate with a lower temperature differential between heating steam and brine boiling temperature. Here again, scale formation is a matter of major concern, and for the successful operation heating surfaces must remain as free from adherent scale as possible.

Other sea-water purification methods

It will be obvious that any method of fresh-water production involving the evaporation of the sea water will always be subject to scale formation on the heating surfaces, and will require the application of feed-water treatments to minimise or prevent this scaling.

Whereas ion-exchange processes are an economic and very satisfactory method for the de-salting of low-salinity waters (up to, say, 2,000 p.p.m. chlorine), they do not offer a practical economic process for the de-salting of sea water (30,000 p.p.m. chlorine). The main reason lies, of course, on the one hand, in the very short operating life of the resin bed before regeneration would be required and, on the other hand, in the excessive quantity and cost of the regenerative chemicals required. There are, however, two alternative methods, based wholly or partly on ion-exchange principles, which are at present under active consideration.

The first of these is based on a possible use of one of the new ion selective resins for the partial de-salting of the sea water, followed by a conventional evaporation process. The High Polymer Group at the Chemical Research Laboratory, Teddington, have recently formulated an ion-exchange resin with the ethylene-diamine tetra-acetic acid radical as the active group (our previously mentioned *Sequestrol* addition in *Admiralty Evaporator Compound*). This resin has been found capable of adsorbing calcium and magnesium ions selectively in the presence of large quantities of the sodium ion (a feature that is lacking in the conventional ion-exchange resin and one that makes its use in sea water an impossibility due to the preponderance of sodium ions). The resin, once saturated with calcium and magnesium, would then be regenerated with the concentrated brine effluent from the evaporator. The proposed technique would be to remove sufficient of the calcium and magnesium from sea water to prevent further deposition when the water is concentrated in the evaporator, thereby eliminating a considerable proportion of the scale deposited.

The second method is that of electrodialysis, where a plastic membrane impregnated with an ion-exchange resin is used as an ionic sieve. A complete electrodialysis unit consists of a series of cells in which are placed a large number of closely spaced membranes having alternate anionic and cationic properties. Each cell is provided with a suitable anode and cathode across which the required E.M.F. is maintained (see Fig. 7). Sea water entering the cell flows between the membranes, the anions passing through the anion permeable membrane, the cations through the cation permeable membrane, and the de-salted water passing up through the centre of the membrane. The caustic catholyte and acid anolyte streams are passed to waste.

Whilst large-scale units are on the verge of development for de-salting low-salinity waters at a very low cost per ton of de-salted water, their application to the de-salting of sea water is still in the research stage. It is the author's opinion that such units will be developed for land use and should be capable of producing fresh water for as low as 4 to 5s./ton. However, for naval application there does not appear to be much promise that they will replace the large steam-heated or vapour compression evaporator. This is mainly due to the space occupied by, say, a 50-ton/day unit compared with one of the conventional evaporators, and also the high power consumption when de-salting water of 30,000 p.p.m. chlorine down to 5 p.p.m.

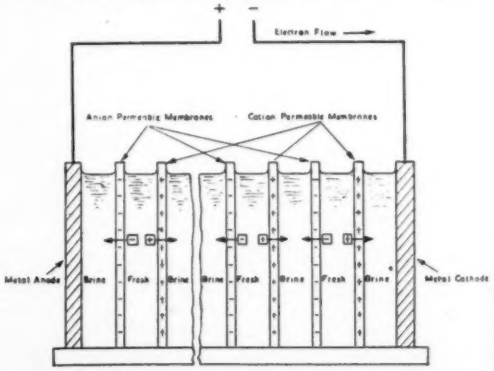


Fig. 7. An electrodialysis cell.

chlorine. There is, however, one exception to this statement, this being the possible development of an electrodialysis unit for submarines, and this field is under active investigation. Here the provision of a unit completely silent in operation, and occupying about the same space as the present vapour compression plant, is the important factor.

One final application of the technique of electrodialysis is the possibility of forming permeable membranes in which is incorporated one of the selective ion-exchange resins such as is based on ethylenediamine tetra-acetic acid. This application is under investigation at present and, if successful, the use of an electrodialysis cell for the partial removal of calcium and magnesium ions from the sea water prior to further evaporation will be investigated. The advantage of this system over the use of the straight complexing resin bed is that it would provide a once-through system and regeneration would not be required.

General comments

Finally, I would like to quote our original terms of reference for this work so that it may be judged to what extent our tasks have been accomplished. These requirements were laid down as follows:

(1) To increase the operating life of existing evaporators without recourse to time-consuming and costly shut-down for coil cleaning.

(2) To improve the economics of fresh-water production by increasing the quantity of water produced per ton of heating steam used and, equally, by the saving in steam to effect a saving in the fuel oil burned in the boilers, and thereby increase the cruising radius of the vessel.

(3) To apply these findings in the design and development stages during the building of prototype evaporators.

(4) To consider and actively pursue alternative methods of fresh-water production from sea water that do not suffer from the effects of scale formation.

Whilst realising that our primary responsibility is for the Royal Navy, it is very satisfying to find that the R.N.S.S. achievements are of undoubted value elsewhere and the Mercantile Marine have been only too anxious to adopt certain of these feed-water treatments on a large scale. In fact, it is of interest to note that several shipping companies have changed from their old practice of carrying fresh water and are now producing their water from the sea water as we do in naval vessels. Obviously, weight and space saved by the non-stowage of fresh water is returning handsome profits in the stowage of additional cargo.

This article would not be complete without a brief reference to the project of the Organisation for European Economic Co-operation to examine the various economic methods of desalting brackish and salt water. It is very gratifying to note that, in view of the Admiralty's experience in the field of salt-water distillation, the R.N.S.S. have been asked to supply a permanent member on the O.E.E.C. Working Party with the responsibility for the interest of Great Britain and the Colonies in so far as distillation techniques are concerned.

This work was commenced in an effort to ensure an economical and plentiful supply of fresh water for the sailor afloat. It is with added satisfaction, therefore, that we can note that this R.N.S.S. contribution may in future help to meet the needs of other nations where, due to dwindling fresh-water supplies, brackish or salty waters may have to be purified to satisfy the increasing demands of industrial and domestic consumers.

Moulding Powder Fillers from Jute Waste

THERE are several types of fillers for plastics moulding powders; the most widely used is wood flour obtained by processing white pine or other soft woods. In India, wood flour has to be imported, and efforts to find an indigeneous source of this material were made at the Indian Lac Research Institute. Various types of wood materials were investigated as to their suitability for the production of wood flour. Some results of the investigations carried out have been reported in the Indian *Journal of Scientific and Industrial Research* (1955, **14B** (3), 121) by P. K. Ghosh, T. Bhowmik and P. K. Bose.

Of particular interest are the results that have been obtained with jute sticks, these being the stems of the jute plant after removal of the fibre and therefore a waste product. Jute sticks were cut into pieces, rejecting a portion 1 ft. from the bottom. The pieces were soaked in water for 24 hr., crushed, dried in the sun, and powdered in a hammer-type disintegrator. The powdered material was sieved through a 100-mesh sieve and the portion passing through was used.

Jute-stick flour and the imported wood flour were analysed and it appeared that jute-stick flour contains a higher percentage of acetone solubles and ash than imported wood flour and also a higher specific volume.

Moulding powders were made using jute-stick or imported wood flour and the impact strength of bars moulded out of these compositions was found. Bars made with jute-stick flour had an impact strength of 4.85 kg./sq.cm., as against 5.21 kg./sq.cm. of bars made with imported flour. Surfaces of moulded articles with jute-stick flour were less glossy; their impact strength also could not be improved by varying the proportion of the flour. Both these defects are due to the high bulk factor of jute-stick dust. A way was found of reducing the specific volume of jute-stick flour.

For large-scale production, jute-stick powder (100 mesh) was soaked in water and pressed between steam-heated rollers. By this method the specific volume of the material could be reduced to 60 cc. By suitably adjusting the pressure of the rollers, a filler of any specific volume ranging between 160 and 60 cc. could be made.

Samples of moulding powders were prepared with compressed jute-stick flour and imported wood flour, both of specific volume 90 cc., and tested. The results show that the moulded articles obtained with compressed jute-stick flour are comparable to those prepared with imported wood flour.

The yield of jute-stick flour from the jute sticks can be improved from 20 to 52% by drying the crushed sticks till they become brittle and then grinding them. The remaining coarse material could be processed once again to obtain 15 to 20% of flour on the weight of material treated.

Super-centrifuges are featured in Bulletin No. 1654 from Sharples Centrifuges Ltd. The principle of the Super-centrifuge is well tried, and results in the material treated being subjected to a centrifugal force of greater than 13,000 times the force of gravity. This is substantially greater, it is stated, than that obtainable with any other type of commercial centrifuge, and it results in a correspondingly higher purifying force. This bulletin shows modern developments in the design of the Super-centrifuge, and illustrates the recently developed range of new models incorporating such features as vertically mounted motors, direct-driven pumps, etc. Examples are given of the use of the Super-centrifuge in industry.

AIR-POLLUTION CONTROL

WORLD PROGRESS—Part 2

By R. W. Moncrieff, B.SC., F.R.I.C.

With something like 25 tons of sulphur being consumed by the world every minute, day and night, throughout the world, there is every opportunity for large-scale pollution. The ideal solution would seem to be to develop processes whereby a great deal of sulphur could be recovered to supplement world supplies and air pollution simultaneously reduced. How far the world's industries have progressed towards this ideal is indicated by Mr. Moncrieff in this article, in which he also deals with some aspects of particle size determination, the design of cyclones and incinerators, and other matters. The article is a continuation of the critical review, begun in our June issue, of the First International Congress on Air Pollution.

The fate of sulphur in iron and steel making

THE very large scale on which iron and steel are made and the fact that both the raw material (the iron ore) and the fuel (coke) contain large quantities of sulphur, together with the importance that is attached from the point of view of air pollution to minimising the quantities of sulphur compounds that are discharged with the gas effluent, warrants a brief consideration of the fate of the sulphur in these processes. The subject was discussed at length by **Dr. Colclough**; some of the salient points are as follows.

In iron-making, the iron ores, which may contain from 0.01 to 0.5% sulphur, are heated in a blast furnace with coke (1,600 lb. to make 1 ton of pig iron) which may contain about 1% of sulphur. It is necessary that the product, pig iron, shall contain not more than 0.05% sulphur and, in fact, only 3.3% of the total sulphur present remains in the metal, the remaining 96.7% being carried away by the slag. In the blast-furnace operation, none of the sulphur passes out into the atmosphere. However, the whole of the sulphur which is eliminated in the sintering operation passes out in the stack gases.

In steel-making, the open-hearth process is widely used; in this, steel is made from a mixture of scrap and pig iron and the heat required is furnished by the combustion within the furnace chamber of different types of gas (*e.g.* producer gas) or liquid fuel in combination with preheated air. The impurities present in the iron, *viz.* carbon, manganese, silicon, sulphur and phosphorus, are reduced to specified limits by passing into a slag which floats on the liquid metal. The combustion of the fuel necessarily has to be complete, and all of its sulphur content is converted to SO_2 by using a considerable excess of air. All open-hearth furnaces used in the United Kingdom generate substantial volumes of SO_2. Attempts have been made, with success, to reduce the output of SO_2 to atmosphere by using as fuel coke-oven gas, which has first been purified to remove most of its sulphur. 'The sulphur pollution of the atmosphere by the steel industry arises not from its processes or its inherent primary raw materials, but essentially from the combustion of the fuels which it consumes.' In fact, the industry removes some 48% of the total sulphur present in the various fuels and in this sense makes a big contribution to the problem of reducing pollution. The two lines of attack which should be followed to secure a greater reduction of sulphur compounds emitted to atmosphere are:

(1) A reduction of the sulphur content of the fuel supplied.
(2) The removal of the sulphur-containing components of the stack gases.

Prevention of hydrogen sulphide pollution

Hydrogen sulphide is so toxic that legal and safety restrictions forbid it being discharged into the atmosphere. It occurs in considerable quantities in coke-oven gas, and it has to be removed before the gas can be used domestically. This purification is done by passing the gas through boxes containing iron oxide which absorbs the hydrogen sulphide; the iron oxide is periodically renewed and the sulphur that it contains is used in the manufacture of sulphuric acid. Contact with iron oxide is one way of removing H_2S.

The recovery of oil-refinery sulphur was described to the Congress by **Mr. G. E. Smalley** and **Mr. J. W. Klohr**, of the Ralph M. Parsons Co., Los Angeles. Crude oils which contain a lot of sulphur were not at one time processed because of the pollution problem that they raised, but because of the increased demand for petroleum products they now have to be used. Such crudes may contain 5% sulphur and in their processing large amounts of hydrogen sulphide are evolved. The first approach to the problem was to burn this to SO_2 in a flare stack before being released to the atmosphere, but the quantities of H_2S that are produced have increased so much with the operation of cracking processes that they are today too large to permit flaring as SO_2. Fortunately, a process of converting the hydrogen sulphide to elemental sulphur has made great progress.

In principle, this process is as follows: one-third of the H_2S is burnt to SO_2, which reacts under the influence of an activated bauxite catalyst with the remaining two-thirds of the H_2S to form sulphur and water:

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$
$$2SO_2 + 4H_2S \rightarrow 6S + 4H_2O$$

The sulphur vapour is condensed and recovered as liquid sulphur.

The residual gases contain only a little H_2S and this is converted in an incinerator to SO_2, which is discharged from a stack at a high temperature, to impart a thermal lift, helpful in dispersing it. The amount of SO_2 discharged is, however, only small because, with a two-stage catalytic converter, 96% of the sulphur in the original hydrogen sulphide is recovered as elemental sulphur.

The process is being run success-

fully and it is said that it is now recovering ' almost 180 tons of sulphur which would otherwise be emitted each day to the Los Angeles atmosphere as 360 tons of SO_2.' Furthermore, ' by the end of 1955, approximately 1,000 tons/day of sulphur will be recovered from sour gases at petroleum refineries throughout the United States.'

There is much to admire in this process: not only does it dispose of the hydrogen sulphide but it results in the by-production of large quantities of valuable elemental sulphur. It is tempting to speculate on its possible modification to remove the SO_2 which causes such a lot of trouble to power stations and industrial operators in Britain.

Effect of sulphur recovery on world supply

The world supply of sulphur was discussed by **Mr. J. C. Carrington,** of the Freeport Sulphur Co., New York. Between 12 and 13 million tons of sulphur are produced and consumed by the world each year; nearly all of it is obtained from pyrites or from naturally occurring elemental sulphur. There is, however, some 10% that is obtained from gases and some 2% from anhydrite. In the United States, about 80% of their sulphur production, which is nearly half that of the world, goes into sulphuric acid. In Canada, half of their sulphur consumption is used in paper-making. In countries that are mainly agricultural it goes into fertilisers, *e.g.* New Zealand consumes 95% of her total sulphur in agriculture and Australia 90%. Some of these uses are unlikely to cause air pollution, but others such as paper-making definitely do so; large quantities of sulphur, too, are used as carbon bisulphide in the viscose rayon process, which is also, unless carefully controlled, liable to cause bad pollution. There is probably insufficient information available to attempt at present an analysis of the world's consumption of sulphur into potentially air-polluting and non-polluting uses, but it is clear that, with something like 25 tons of sulphur being consumed by the world every minute day and night throughout the year, there is every opportunity for large-scale pollution. Furthermore, enormous quantities of sulphur-containing fuels are used and from these even more pollution may be expected.

The quantity of sulphur recovered from sour gas in the petroleum industry in the United States alone was estimated for 1954 at 350,000 tons and will be more in 1955. Within the period 1949 to date, the number of such recovery plants has increased from 4 to over 30. The drive to reduce atmospheric pollution at refineries has exerted a strong influence in this development; so, too, has the value of the recovered sulphur. This sulphur produced in the United States alone from the H_2S of sour crude oil already accounts for some 3 to 4% of the world's production of sulphur.

Another source of sulphur which, as it is developed, has a direct bearing on the reduction of atmospheric pollution, is the stack gases of smelters who treat sulphide ores for the recovery of copper, lead and zinc. The smelter gases may be used in the manufacture of SO_2 or of ammonium sulphate; more usually they are converted in contact acid plants to sulphuric acid. The more sulphur is obtained in these ways as a by-product of other processes the better. All the sulphur that is so recovered in whatever form, as sulphur dioxide, as sulphuric acid, or as elemental sulphur, means that so much less sulphur is being allowed to pollute the atmosphere.

Aerosol particle size

In any consideration of particulate pollution, *i.e.* pollution not by gases but by particles, the size and range of size of the particles are clearly important. **Mr. D. Sinclair,** senior research physicist at the Johns-Manville Research Center, New Jersey, described an optical method of measuring the average particle size in aerosols. Particles with diameters below 0.5μ cannot be measured or counted in the light microscope, but Sinclair's method, which consists essentially of the measurement by phototubes of the light scattering caused by particles, will take account of particles down to 0.1μ. The method involves a determination of the ratio of small-angle forward scattering (2 to 10°) to right-angle scattering; this ratio varies from 2 in the Rayleigh region to about 500 with particles of 6μ diameter. In the case of a non-uniform particle size aerosol—and this covers all that are likely to be met in practice—the method will give an approximate average particle size, but it will tell nothing about the *distribution* of particle size; it can, however, indicate that the predominant size falls within a certain range. The approach is novel and in an early stage of development, but it is one that should be worth exploring by physicists and other scientists who require more exact knowledge of the nature of air pollution, and such knowledge will probably be a prerequisite for successful treatment of many forms of atmospheric pollution.

Design of equipment

Some of the papers that were presented to the Congress described design features of equipment; these would undoubtedly be of great value to other companies or organisations working in a similar or closely related field, because they had presented to them the results of experience and practice. For example, **H. J. van Ebbenhorst Tengbergen,** mechanical engineer of the Mining Research Establishment, Limburg (Netherlands), discussed the influence of the size of the dust outlet of cyclones on their efficiency. The main object of the work was to find the quantitative influence of leakage on the collecting efficiency, and to compare various types of construction with the idea of diminishing the disadvantage arising therefrom.

Another paper that was of considerable importance from the engineering standpoint was entitled ' Incinerator Design Standards: Research Findings ' and was presented by **Mr. A. H. Rose** and **Mr. H. R. Crabaugh,** of the Air Pollution Control in Los Angeles. As a result of the force of public opinion, an engineering evaluation of incineration was undertaken in 1949 by the Los Angeles County Air Pollution Control District Engineering Division. Subsequently, in 1954, with the co-operation of the American Society of Mechanical Engineers' Committee on Air Pollution Controls, a sub-committee on incinerator design standards was set up.

The existing knowledge relating to incineration is empirical rather than theoretical and, according to Rose and Crabaugh, ' insufficient sound engineering data are available to provide sufficient correlation for the determination of empirical design parameters.' The information presented in their paper shows that a multiple-chamber incinerator is the best, as it performs stably over the widest ranges of fuel volatility and composition, ash content and moisture content, bulk density, heats of combustion and firing rates. In practice, a two-stage incinerator is recommended; in the first stage the refuse which is to be incinerated is dried, ignited, the carbon is burnt and the volatile components are mainly burnt up; in the second stage air is introduced and combustion is completed. Information is given as

to suitable dimensions for the ignition chamber, secondary chamber, flame port, etc., of the furnace, as to the effect of temperature and furnace design on the per cent. combustible in the solid contaminants discharged and as to the per cent. of acid and volatile organic contaminants discharged and on related data, including the 'relationship of the material burned to the formation of acid and volatile organic compounds.' The information given in the paper would be of considerable help to incinerator designers who are anxious to reduce air pollution to a minimum; the authors themselves point out the incompleteness of their tests and the inadequacy of their results, and urge the need for more work to be carried out on the subject.

Towards cleaner air

In this concluding section some general impressions gathered at the Congress are grouped; most of them are from **Sir Hugh Beaver's** lecture.

It cost £100 to clean the glass at Kew Gardens after a fog—a striking illustration of how industrial smoke shuts out daylight and obliges us to work in artificial light in the daytime, with resulting inefficiency and ill-health. How much air pollution costs the world in ill-health, absence from work and damage to plant and property cannot be estimated at less than hundreds of millions of pounds sterling a year. Particulate pollution in the United Kingdom comes largely from domestic open grates in which 30 million tons of coal are burnt each year, unnecessarily polluting the air and throwing away valuable chemicals; people should be encouraged to burn coke, which shows a big advantage over coal in both of these respects. To the author it seems that the old incentive to burn coke domestically was its lower cost; today the differential in price between coal and coke should be restored and then more coke and less coal would be burnt by the community. In industry a good stoker is stack-conscious, he does not like to see black smoke coming out of his stack, but the householder pays no more attention to *his* chimney than the engineer of a liner in mid-Atlantic pays to his. Most of the heat generated in domestic fires goes up the chimney.

Clean air is a primitive requirement, and one bountifully provided by a beneficent Nature, but one that nowadays is not enjoyed by countless millions who should enjoy it. It should be fought for, as clean water was fought for and gained a hundred years ago. Some £3,000 to £4,000 million has been invested in Britain's water and sewage system; now some £75 million should be spent, according to the Beaver report,[3] within the next 15 years on the provision of clean air. If it is true that air pollution is costing Britain alone £250 million a year, and if the steps that are recommended to be taken would materially reduce this wastage, they should be taken by any hard-headed industrial body or government, quite irrespective of the humane and aesthetic issues involved, which point equally strongly in the same direction to the need for action.

Amongst the proposals made by the Beaver Committee in their final report there are:

(1) All previous legislation should be swept into a new act called the Clean Air Act (it seems now that the Government, with support from the Opposition, will introduce such a Bill).
(2) Legislation should be nation-wide, so that there is no chance to push a pollution nuisance from one district to another.
(3) It will not be necessary to *prove* that dark smoke is a nuisance; it will be taken for granted.
(4) There will be no protected industries, immune from the provisions of the Bill.
(5) Concentration on amelioration of the black spots of the country.
(6) The introduction of semi-smokeless zones (better than an unattainable counsel of perfection) in which smoke will be reduced by 80%.

The final report of the Beaver Committee was forthright and bold and its main recommendations have been accepted in implication by industrialists and government parties. Such congruence of opinion stems from the arousal of *public* opinion by the London smog of 1952.

The results of this legislation should be beneficial, but they may not be so immediately beneficial as might be hoped. There is not a tremendous amount of *exact* information about the best ways to avoid air pollution; there is reason perhaps to doubt if all the emphasis placed on the SO_2 content of effluents has been merited—the power stations that wash out the SO_2 from their smoke get more complaints than those that do not wash. Does the SO_2 itself present in the air of an industrial city affect the lungs, or does it do so only if it is adsorbed and concentrated on the carbon of the smoke particles which are inspired when we breathe the smog? If the latter is the case, more benefit might be derived from removing particulate pollution than gaseous. There was evident, too, at the Congress some diversity of opinion, even amongst the experts, as to the value of a high temperature and tall stacks for the gaseous effluent; some of those who should have known thought that effluent forced, as a hot gas, out of high stacks was soon dispersed; others, more academically inclined, deplored the loss of sensible heat. In California, where the very stillness of the air was responsible for its delightful climate, that same stillness is now responsible for the air pollution.

From the standpoints of health and cleanliness, the removal of particulate material might seem to be our best first step. From the standpoint of reducing air pollution, the two things that are most urgently required are more knowledge of the factors involved and more research to gain that knowledge.

REFERENCE

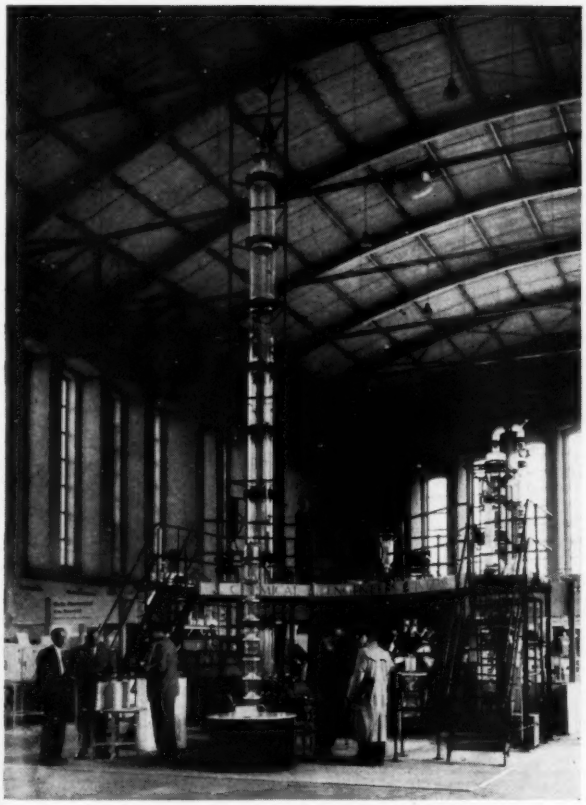
[3]Sir Hugh Beaver *et al.*, 'Report of the Committee on Air Pollution,' H.M.S.O., London, 1954.

Switchboard instruments. Measuring Instruments (Pullin) Ltd. have sent us the latest edition of their catalogue section 'B,' illustrating and describing their range of industrial switchboard instruments, which has been completely revised and brought up to date. This publication includes a general specification for this range, along with prices and various data for instruments and accessories.

Crushers. The British Jeffrey-Diamond 'rock buster,' described and illustrated in a new pamphlet, is stated to be capable of reducing any hard friable material from a maximum feed of 36 in. down to 90% −1½ in. in one stage. Product size can be controlled by adjustment of any or all of the following three elements: (1) speed of the rotor, (2) spacing of the rods in the upper part of the machine—accomplished by using spacing blocks of various widths, and (3) the shelf arrangement of two or more large shafts on which are mounted heavy manganese steel rings—accomplished by the movement of a large lever on the outside of the frame which changes the distance between the rings and the periphery of the rotor. The pamphlet gives typical results for a type 303 unit and a specification of the 'rock buster' with capacities on average medium-hard limestone-T.P.H.

New Chemical Plant at the Achema XI

A Successful Exhibition and Congress on the Continent



Top: **A view of one of the halls at the Achema.**

Bottom: **One of the comparatively few British stands, that of Q.V.F. Ltd.**

As we predicted in our 'Achema XI Pre-View Issue' in April, this year's exhibition of chemical plant and apparatus at Frankfurt-am-Main, Germany, together with the congress associated with it, surpassed all previous occasions both in size and attendance. The record figures show the increasing importance of the chemical plant industry in Europe as well as the importance attached to this exhibition and congress. The number of exhibitors was some 850, *against* 563 *for the Achema X held in* 1952, *while the total number of visitors reached* 71,350, *against* 45,881.

Although the exhibitors at the Achema XI were predominantly German, the number of foreign exhibitors was greatly increased this time, 106 *firms from* 13 *different countries being represented. This being so, it is surprising that only a dozen or so exhibitors were British. For, while the organisers of the Achemas do not regard them as trade fairs but rather a means for examining the latest technical developments, there is nevertheless, obviously, an opportunity for exhibiting firms to make themselves and their products better known to possible customers. The few British firms who did exhibit seem to have made the most of it; for example, Q.V.F. Ltd., who took with them apparatus for providing their own steam, vacuum and air supplies for their working exhibits. The* 40*-ft. glass tower which formed the centre-piece of this firm's stand drew a good deal of interest. Isopad Ltd. were another British firm*

who reported favourable results. But no matter what their nationality, most of the exhibitors had some new product or process or improvement to present, and the tirelessness shown by technicians in giving information and discussing technical points was a great contribution towards the exhibition's success.

Visitors converged on Frankfurt from 52 different countries, some 49% of those registered by name being non-German. The European Convention of Chemical Engineering, with which the Achema XI Exhibition and Congress was connected, included a very full programme of scientific and technical meetings. One important development was the formation, with the participation of various Continental societies, of a European Federation of Corrosion, aimed at fostering European collaboration in corrosion research.

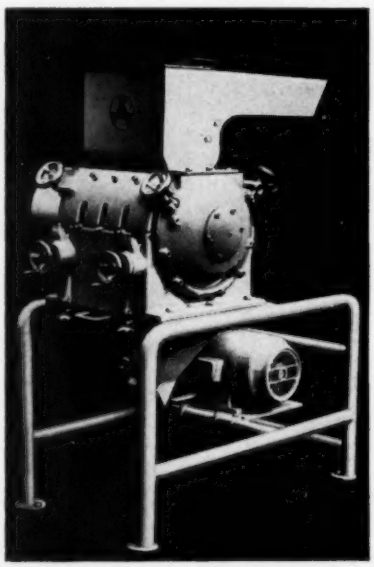
The Achema XI was organised by Dechema—Deutsche Gesellschaft für Chemisches Apparatewesen—whose title has been translated as 'German Society of Chemical Engineering.' The declared aim of this organisation is to further development and advancement of chemical apparatus and equipment, chemical engineering, and process techniques on a mutual benefit basis, and its membership includes individual engineers and scientists as well as organisations, commercial firms, etc. It is thus distinct from the European Federation of Chemical Engineering, which held its congress at the same time as the Achema and in the same exhibition grounds in Frankfurt. Membership of the Federation is confined to European scientific societies concerned with chemical engineering.

The success of the Achema XI, and the great wealth of new developments revealed there, have prompted us to undertake an illustrated review of the exhibition as a sequel to our illustrated pre-view in April. On this and the following pages, therefore, we present details of some further interesting exhibits. Again we have been dependent on exhibitors for information, and thank them for their co-operation.

A.E.G. (Allgemeine Elektricitäts-Gesellschaft), Berlin. A display of **indicating and recording equipment** in explosion-proof housing included a selector device by means of which a number of variables may be recorded at choice on the one instrument. A pivoted coil compensator is used for zero adjustment, giving rapid operation. Telemetering equipment included an inductive coupling, with a rare-metal winding on a ceramic ring, which requires neither contacts or leads; a turning moment of 0.2 g. cm. operates the ring, which is inductively linked to an a.c. network. A small pivoted coil controller was shown in operation in a temperature controller. The d.c. from the controller is lead through a magnetic intensifier feeding a small heating coil; the exit temperature of gas passing through the coil is recorded by a resistance thermometer and transferred to the scale of the recorder. A larger regulator was shown in use in a liquid level and flow controller. Another exhibit was a new type of switching device using a double manometer enabling smooth transfer to take place from manual to automatic control.

The Guinier instrument for ***X*-ray analysis**, devised by Dr. H. Jagodzinski, combines a double-cylinder chamber focussing device with a quartz crystal monochromator. The *X*-ray tube has an adjustable focus (using electrostatic lenses), from 25×10^{-3} to 150×10^{-3} mm., on a water-cooled anode. Resolution is sufficient to enable the $K\alpha_1$ lines to be used alone, avoiding the background radiation; the makers state that this is especially useful for investigation of small angle scattering such as occurs with plastics, as well as providing a greater precision for general operation.

Other equipment on display included a photoelectric intensifier which enables continuous measurements to be made of relative light intensities, either indicating or recording. This finds application in turbidity measurements in liquids, smoke density measurements, transparency measurements in photographic material and temperature comparisons of hot bodies. A drop counting machine operating at very short time intervals (between 10^{-1} and 10^{-4} sec.) finds applications in packing processes, *e.g.* where measurement may be made of freely falling objects. Selenium rectifiers have been developed mainly by A.E.G. and are illustrated by an oil-cooled rectifier for 10 v. and 600 amp., where the d.c. voltage may be varied continuously over 100%. The **magnetic vibrators** that were shown, operating with a twin-pendulum spring system, are stated to combine free operation with a low energy requirement and enable solids to flow through pipes in a fluidised manner. These units are of up to 250 metric tons/hr. capacity in some cases, *e.g.* for coal. Where long flow paths are required, a number of units may be put in series along the pipe, covering lengths of up to 8 to 10 m. Special steels permit operation at up to 600°C.

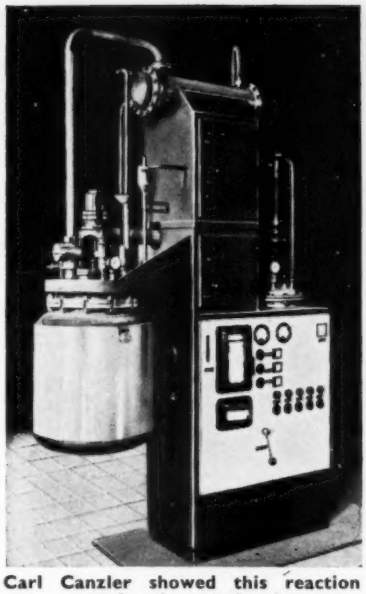


'Rotoplex' rotary cutting mill, exhibited by Alpine A.G.

Alpine A.G., Augsburg. A range of **grinding and classifying equipment** for industrial use includes the *Contraplex* high-speed mill, giving close control over the fineness of the product, which utilises oppositely rotating toothed discs, and the *Colloplex* mill, which is suitable for milling heat-sensitive materials. The *Perplex* universal mill is available with various interval milling arrangements; a model on show was fitted with pendulum-type hammers. The *Superplex* mill is a high-energy hammer mill, the heat developed being carried away in a stream of compressed air; thus heat-sensitive materials may be milled. The *Biplex* mill has horizontal bearings for two toothed discs, and is suitable for the pulp and paper, cellulose, and cork industries.

Equipment for the plastics industry includes the *Rotoplex* cutting mill, available in two sizes, which is an effective granulator for all plastics; it is robustly constructed and has a high continuous load capacity. Various small mills manufactured include the *Perplex* laboratory mill, which is available in corrosion-resistant materials; the *Colloplex* mill; a roller mill; laboratory ball mills; and the *Bulldog* crusher, which may be easily adjusted to different crushing widths.

Calor Emag. A.G., Ratingen. The **ring rectifier** displayed was a mechanical rectifier with a high efficiency over the total load range, and is especially suited for high-current electrolysis at up to 800 v. Among advantages claimed for this design are the simplified construction and the uniform operation of the rolling contacts. The alternating current feed and the rectified current leads are connected to two cylindrical tracks, into each of which are fixed insulated metal segments. The number of segments is a multiple of three, corresponding to the number of phases and the size and design of the machine. The rotating contact rollers connect the a.c. feed with the rectified tracks in phase with the feed supply and thus effect the rectification. The makers state that the good cooling by the movement of the rollers and the short time of operation of the individual contacts permit a high effective current load. Sliding and diameter relations between the rollers and the inner track result in different contacts taking the current after each rotation. Control is attained by rotating the stator of the synchronous motor driving the rectifier. The rectifier exhibited was designed for 4,000 amp. and 400 v.; it is stated that it may be operated at full load with lower voltages.



Carl Canzler showed this reaction vessel and control unit.

Carl Canzler, Duren. Equipment shown by this firm was as described in our 'Achema XI Pre-View' issue in April. The **inducting heating unit,** comprising an enamelled mild-steel vessel with induction coils in the jacket, was developed in collaboration with the firm of Pfaudler, Schwetzlingen, and the heat is uniformly and regularly distributed over the whole of the internal surface by this method of construction.

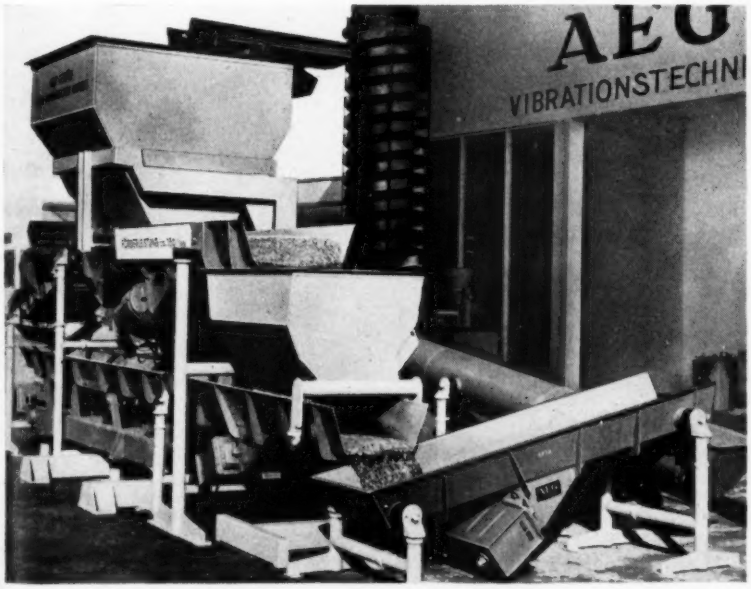
Tubes and assemblies of corrosion-resistant steels were also shown and, in addition, valves made of plastics such as polyvinyl chloride.

David & Baader, Kandel Pfalz. Among the **electrically heated equipment** displayed was a drying oven for laboratory use; this can be adjusted to provide an inlet of heated air or to operate with closed circulation or as an exhaust ventilated oven. The oven operates over the range 20 to 250°C., ±2°C., and is manufactured in a range of sizes from 0.6 to 10 cu. m. capacity. A smaller laboratory drying oven, in sizes 30 to 180 l., operates over the temperature range 20 to 220°C., ±1°C. Another small unit with a cylindrical aluminium muffle is available; this has a diameter of 36 cm. and a depth of 25 cm., and is also fitted with a temperature regulator accurate to ±2°C. over the range 40 to 200°C. For lower temperature ranges, a type of oven with capacities of 45 to 80 l. is available covering a range of 20 to 100°C., with a directly operating thermostat. A laboratory muffle furnace, with a maximum temperature of 1,000°C., has a loading of 5 kw.

Various specialised heaters and vessels are supplied, including an electrically heated impregnating vessel, for cable impregnation, with automatic temperature control; air heaters for textile machinery and also for space heating. The firm also manufactures a range of industrial heating elements of all types, available with brass, copper, steel, chrome steel, or in nickel- or chrome-plated, or galvanised, tinned, or lead-coated heating elements.

J. C. Eckardt A.G., Stuttgart-Bad Cannstatt. The effective-head method of measuring flow as differential pressure by means of a head meter is not suitable for highly viscous flow which can be regulated only on the volumetric principle, this company points out. **Piston meters** are used for this purpose and the company have been making them for many years in a range of capacities. These meters are suitable for liquids with a viscosity of up to about 25° Engler and temperatures up to 170°C.

The actual viscous-flow rate time unit is controlled by a pneumatic transmitter actuated by the piston meter.



Handling equipment exhibited by A.E.G.

This auxiliary device produces air pressures between 0.2 and 1 atm. proportional to the mean number of revolutions of the meter drive as a measure of flow volume.

Eisenwerke Kaiserlautern, Kaiserlautern. This firm specialises in **glass-enamelled steel equipment**; acid-resisting glasses have been developed which, the makers claim, are extraordinarily resistant to acid attack at temperatures up to 350°C., being completely unaffected by solvents, in contrast to plastic coatings; it is further claimed that superior thermal conductivity and hardness are obtained. A point is made that the great disadvantage of enamelled vessels is the brittle nature of the enamel, and the company have recently developed a new enamel, E.G. 54, which has considerably improved properties in this respect. The impact resistance is stated to be four times as great as normal enamels, while the resistance to temperature changes has been improved to give a coating which is stable to shock cooling from 350°C. to room temperature, compared with 200°C. for normal enamels. The E.G. 54 enamel also gave a surface free from crazing on repeated temperature cycles to intermediate temperatures. This enamel should enable the range of applications of enamel-lined vessels to be considerably extended, say the makers.

A. M. Erichsen GmbH., Hemer-Sundwig/Westphalia, manufacture **test equipment** for varnishes, paints, enamels, etc., as well as for sheet metal and metal strip of all types. Model 223 is a new material-testing machine for paint and varnish and yields data on porosity, elasticity, adhesivity and ageing. The control is visual, by microscope, or by a specially designed electric technique. Hardness penetration tests can be read to an accuracy of 0.01 mm. Penetration can be produced gradually or by impact.

Model 224 is of interest for the metal-container industry. The following can be tested: soft metals, 0.1 to 0.8 mm. thick (10 kg./cu.mm.), aluminium; and hard metals, 0.1 to 1 mm. thick (40 kg./cu.mm.), iron or brass. Circular test pieces are punched and pressed to form cups of 33 mm. diameter, cylindrical, or 45 × 45 mm. square. This is done in one movement taking only a fraction of a second.

Other testing equipment is also manufactured, especially for testing sheet metals for their suitability to deep drawing processes.

Erweka Apparatebau GmbH., Frankfurt-am-Main. The new Stada **multi-purpose machine,** which has one driving unit for the operation of 15 different apparatuses as required, was referred to in our April pre-view of the Achema. An interesting feature is that the basic driving unit can be applied for driving a small, modern, precision tablet press which corresponds to a large press in construction and operation. The dry granulator can also be driven by the basic unit and makes the economical production of tablets possible. The substances are pressed into briquette form for subsequent breaking down in the granulator. It is stated that, as a result of the double-roller system with corresponding toothed combs, the proportion of power produced by the dry granulator has been reduced to 20%, provided the briquettes are in proper condition. The moist granulator enables the granulation of materials that have previously been moistened.

W. Flämrich, Recklinghausen. This firm exhibited **sieves** constructed on the resonance principle. Sieving has always presented a problem in plant design, as the vibration necessary for the operation of the sieves becomes communicated to the rest of the unit, resulting in a need for much stronger construction than would otherwise have been necessary. A pioneer in the design of sieves was Schlieferstein, to whom many patents and much progress in this field may be attributed. In recent years the main development in sieving has been to use the swinging principle, by means of which the horizontal as well as the vertical component of the momentum of the sieve plate may be absorbed. Flämrich had on show a resonance sieve constructed on this principle. The framework makes a small movement in the opposite sense to the movement of the swinging sieve frame; by this means the horizontal component of the momentum is neutralised. In order to reduce still further the disturbance to the building, the whole assembly is mounted on horizontal rubber rollers which move together slightly and absorb the vertical force component. Among advantages claimed for the resonance sieve is a greatly reduced power consumption, owing to the conservation of momentum. Thus for a sieve of 1.6 × 5 m. in dimension the power required is only 2 to 3 h.p. The sieves are adjustable to suit the feed.

Two Flämrich resonance conveyors.

The same principle of resonance has been used to transport solids of up to 20 gauge. Granular material may be more easily transported than fine powders, but it has been possible to transport cement by this means.

Gebrüder Klees, Düsseldorf, exhibited a range of specialised **laboratory equipment.** A portable *p*H meter, 15.5 × 12.5 × 5 cm., weight 1.5 kg., is suitable for use with the glass electrode or antimony electrode; range 0.5 to 10.5 *p*H (glass), ±0.1 *p*H.; 0 to 13 *p*H (antimony), ±0.2 *p*H; working off 30-v. anode and 1.5-v. filament batteries. A d.c. amplifier shown was stated to be especially suitable for control purposes, retaining stability over long periods, while a *Cycloid* magnetic stirrer is claimed to give more complete mixing than conventional rotary types. A high-speed turbine mixer, with all parts coming in contact with the liquid made of plastic, was among other exhibits, and a high-frequency generator for melting small samples (10 g.) for combustion analysis of steel; this also finds application for other thermal processes, *e.g.* sintering reactions at up to 2,000°C.

The *Autotit,* an automatic burette with a mechanical filling device, is claimed to increase accuracy by reducing zero point errors. Combustion furnaces for temperatures up to 1,500°C. consist of a silit tube, which serves as a combined furnace tube and heating element. Continuous operation at 1,450°C. is possible, and it is stated that the life of the silit tube used is considerably better than in previous types.

Geiger counters were exhibited, working at up to 10,000 impulses/min., together with suitable monitoring equipment, accurate to ±15%, and also a precision coulometer, working on the impulse principle.

Gustav F. Gerdts, Bremen. This firm exhibited a range of **condensate let-down equipment,** including a number of special items. The main

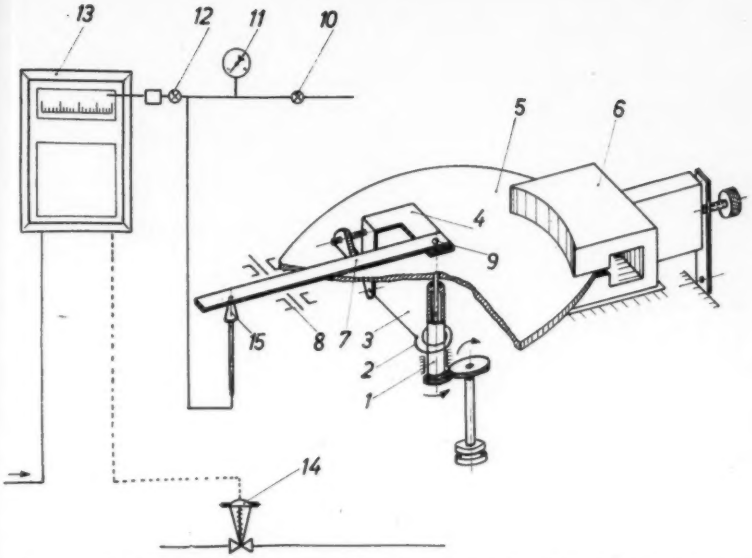


Diagram showing details of pneumatic transmitter for the piston volumeter shown by J. C. Eckardt A.G. Key to numbered items: (1) shaft; (2) spiral spring; (3) draw rod; (4) angle lever; (5) disc; (6) U-magnet; (7) flapper; (8) bearing; (9) support; (10) restriction; (11) measuring pressure gauge; (12) attenuation device; (13) pneumatic controller; (14) control valve; (15) nozzle.

item was the new type of multi-stage jet. This is the basis of the *Gestra* condensate let-down valve which, according to the makers, has a very speedy response, there being practically no delay in operation. It is stated that the *Gestra* valve principle has been incorporated in equipment to suit a range of operating conditions from low to the highest pressures, for each of which a special design of valve has been made. On show was an automatic condensate valve, which can deal with large volumes of condensate in seconds, enabling rapid drainage. This is fitted with visible controls to show any variation from normal operation. A larger model, to deal with quantities of condensate such as are obtained in the sugar industry, was also shown.

A thermostatically controlled condensate valve was shown in which the sensitive element is placed at the point where the condensate shows the greatest variations, in order to give the highest sensitivity. The *Gestra* axial slide was displayed; this is claimed to give a completely vapour-tight seal.

Other equipment on show included an *X*-ray level indicator; and desalting equipment, which has been used extensively for locomotive boilers, along with a new design suitable for small boilers.

Hartmann and Braun A.G., Frankfurt-am-Main. A **laboratory *p*H meter** for general use was shown, suitable for *p*H determinations with quinhydrone, platinum and antimony electrodes and also for various glass electrodes; in addition, redox potential determinations may be made and the instrument can be used for electrometric titrations. Temperature compensation is manual or automatic, using an electrical resistance thermometer. Dead-stop and amperometric titrations can also be carried out.

Electrodes suitable for plant use with flowing liquids were shown. The antimony electrode is normally usable at up to 40°C., but a special assembly is available for up to 100°C., suitable for use at up to 6 atm. pressure. The *Uras* continuous infra-red gas analyser is suitable for measurement of concentration of gases such as CO_2, CO_2 and hydrocarbons. The instrument is selective, so that interference by other gases with strong adsorptions in a different part of the infra-red spectra is not experienced.

A. Hettich, Inh. W. Eberle, Tuttlingen/Sudd, included two new **high-speed centrifugals.** These have a capacity of 6 to 10 ml. and a speed of 16,000 to 17,000 r.p.m., enabling them to be used for the separation of liquids which have hitherto presented great difficulty. One of the centrifugals was fitted with a refrigeration system which enables the machine to be operated continuously at temperatures down to −26°C. The other machine was provided with a forced draught by means of which the temperature within the separation chamber could be maintained at from 6 to 7° above room temperature over prolonged periods of operation.

This *p*H meter was shown by Hartmann & Braun.

The other machines made by Hettich have been considerably modified and improved in regard to their external appearance and safety in operation. The versatility of all these machines is increased by the fact that a large number of different types of heads are available.

Isopad Ltd., London. This company report that a lively interest was shown in their **electric surface heaters,** shown on the stand of their German distributors. A particular attraction was the 'Multisize' design, making possible the use of one single mantle for a variety of sizes of both round- and flat-bottomed flasks. The circular opening at the base avoids the formation of air pockets and it also allows the mantle to be used for funnels as well as flasks. The element assembly is held in the metal casing by a spring device, so that the element can be quickly changed should the need ever arise.

Type IMM are *Isomantles* in metal casing, made for individual flask sizes and similar in appearance to the 'Multisize' mantles. The element assembly is also of the quickly changeable type and the mantles are made for all flask sizes from 50-ml. up to 200-l. capacity. A further type (IMS) are glasscloth-covered heating mantles with built-in supports, made from micro sizes for 5-ml. up to 1-l. capacity.

The *Isomantle* extraction unit consists of a number of independent, glasscloth-covered heating mantles of the 'Multisize' design. Type SEU is suitable for all sizes of flasks from 50 to 350 ml., and type DEU for flasks from 250- to 1,000-ml. capacity.

The mantles are contained in an enamelled metal housing which is supplied complete with controls, neon indicators and vertical and horizontal supporting rods. If desired, the heating mantles can be used outside the housing.

Isomantles are also made for plant vessels up to 500-gal. (2,500-l.) capacity. For heating and heat compensation of cylindrical vessels, storage tanks, etc., *Isopanels* (flexible heating panels) are available.

Klöckner-Humboldt-Deutz A.G., Köln-Kalk. The undesirable reduction of grain size which often takes place in continuous discharge centrifuges is avoided in the Humboldt vibrating-screen **centrifuges** by applying axial vibration to the rotating, slightly conical, perforated basket. This effect results in a reduction of friction between the walls of the screen and the charge, as well as in the mass itself, so that a constant rate of discharge is obtained without any mechanical discharging device. The solids form a uniform layer over the whole surface of the screen with a thickness which can be controlled as desired. The mass is maintained in constant motion resembling that of the flow of a liquid and is alternatively compressed and loosened so that the separation of the water is greatly facilitated. It is stated that high rates of production of material with low moisture content are obtainable with the application of relatively low centrifugal force and correspondingly reduced power consumption.

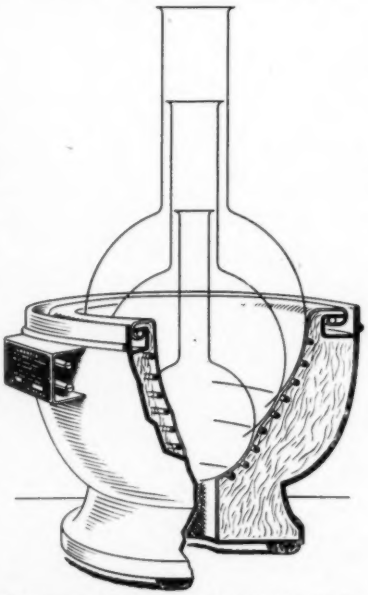
Wilhelm Lang K.G., Bad Homburg. The display on this stand included **diamonds** for a variety of purposes including the truing up of grinding wheels; dressing paper calendering machines and cotton rollers; working hard rubber, fibre, artificial horn, etc.; working tempered steel, for hardness testing apparatus of all systems; and other applications.

The *Wila* deep-gripping jaws are clamping tools of many-sided applicability, especially suitable for holding work pieces on machine tools such as planing and shaping machines, milling, boring, slotting face grinding machines, horizontal boring and jig-boring machines, etc. The makers point out that these deep-gripping jaws can be used to advantage as standard chucking element for newly designed jigs and fixtures, which fact would make a cheaper and faster production of these latter possible, since one and the same chucking element could thus be used on various fixtures. Among advantages claimed for this device, apart from the deep-gripping effect, are increased chucking power, unlimited chucking width, precision make (all sides are surface ground) and light weight.

Lewa O.H.G., Leonberg b. Stuttgart. This company were showing their **proportioning pump,** stated to have applications in the chemical and pharmaceutical industries, high-pressure processes, synthetic fibre production, water-conditioning plants, mineral oil industry, food and paper industries, etc. The driving parts run in oil in a completely sealed casing. Wide-scale graduations are provided and the selected stroke length is clearly indicated. A further feature of the pump is that all pipe connections are mounted on one side, thus ensuring tidy duct runs.

The assembly is composed of a pad carrying a flange-mounted geared motor, one or more pump elements, including their respective pump heads, and the terminal pad. The actual pumping parts, *i.e.* the pistons or diaphragms and valve components, are housed in the pump heads which are held to the individual driving-gear units and maintained in correct alignment by special brackets. The pump element driving-gear units are standardised.

Each element is a self-contained pump, although its rotational speed is governed by that of any other elements to which it may be coupled by the common eccentric shaft. All elements can be regulated by stroke adjustment —normally effected manually by means of the hand-setting wheel, although automatic control is possible.



Diagrammatic view of 'Multisize' Isomantle apparatus displayed by Isopad Ltd.

Maschinenbau A.G. Balcke, Bochum. An interesting range of **plant for the chemical and allied industries** was represented. Items listed include plant for feed and cooling water circulation in power plants, cooling towers, natural or forced draught, evaporative coolers, condensation plant (including surface and spray condensers), vapour pumps, heat exchangers, complete units for water conditioning, heating systems, waste-steam recovery units and gas- and oil-fired furnaces. The forced-draught cooling towers are fitted with hydraulic drive, enabling exact control to be exercised over the degree of cooling of the circulating water. The Frankenthal works engages in the manufacture of pumps and compressors, including centrifugal pumps with heated casings, piston pumps for pastes and viscous liquids, injectors, calibrated feed pumps, vacuum pumps (piston and rotary types), rotary compressors for industrial gases, *e.g.* nitrogen, carbon dioxide, ammonia, methane, ethane, etc., and pumps for these liquefied gases. Fire-fighting equipment is also manufactured.

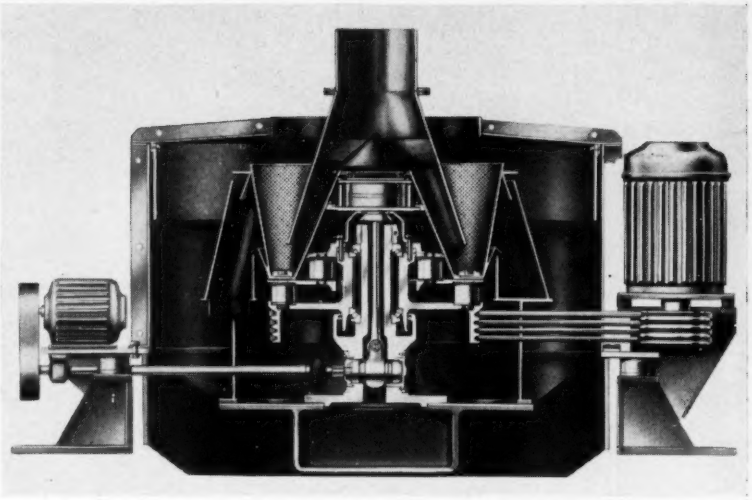
Ludwig Pallmann, Zweibrücken. Turbo mills, embodying what is described as a new technique for disintegration, were featured by this company. Examples given of applications for these machines include grinding, without screens, a variety of materials to fine powder, and 'fibre-ising' wood, wood shavings, cellulose, leather and a variety of other materials, wet and dry. This machine operates on entirely different principles from the normal rotary disintegrator and can perform the functions of grinding, granulating or shredding as required.

Inside a saucer-shaped chamber a high-speed centrifugal wheel flings the material against the segment surfaces of the housing. The air in the saucer-shaped chamber is compressed. The resultant air thrust forces the disintegrated material through the ring-shaped outlets between the housing and the centrifugal wheel. The segments which provide the working surfaces of the mill are manufactured from wear-resistant steel and are held in position in the saucer-shaped chamber by means of a circular flange. The complete set of segments can be removed and replaced rapidly by removing this circular flange. The centrifugal wheel can be removed in a few

minutes by loosening the female screw to permit easy and thorough cleaning of the mill.

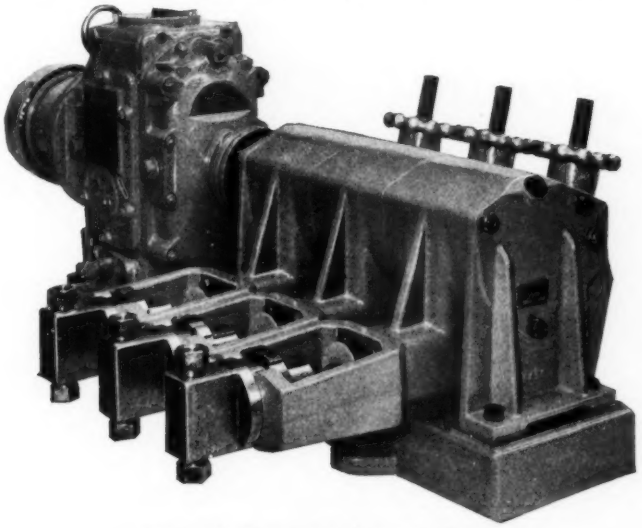
Pass & Co., Weidenau. This firm displayed items representative of a range of **acid-resistant equipment** including castings and vessels for the chemical, pharmaceutical, cellulose, paper, textile, milk, food and beverage industries. Some idea of the versatility of this company can be obtained from a list of products which includes buckets, litre measures, ladles, pans, tanks, transport containers, cans, screw conveyers, milk cans, autoclaves, pressure vessels, evaporators, boilers, filter vessels, fermenting vessels, paint kettles, level tanks, evaporating pans, tubes, bends, joints, tube systems, etc., pickling baths, and pans, galvanising tanks, developing dishes, photographic tanks, beer cans, thermos flask containers, food containers, stirrers, clad metals, laboratory vessels, dye vats and tanks.

Julius Peters, Berlin. In addition to their oxidising apparatus for rubber, etc., *Rekord* calorimeter and other apparatus, this firm showed an interesting apparatus for determining the evaporative capacity of engine lubricating oil. A sample of oil is weighed in a sealed crucible and heated to the temperature of test (250°C.) and the oil steam is sucked off with a constant pressure difference. The loss of weight during 60 min. is determined. The suction pipe of the evaporating crucible is connected with a Woulff bottle and a manometer. The oil steam is sucked off through the Woulff bottle in which the oil distillates are collected. Suction is effected by a small revolving pump or by a water-jet pump. The crucible is heated *via* an aluminium block which is electrically heated from an outside source. The block also has two bores to take the normal thermometer and the contact thermometer.



Scheme of vibrating-screen centrifuge shown by Humboldt.

Another apparatus shown was for **testing the oxidation stability of gasoline** under conditions of accelerated oxidation. The tendency of gasoline to form gum in storage is indicated by the induction period. The induction period is calculated beginning at the point where the bomb included in this apparatus is exposed to the test temperature in the bath, and ends when the 'break point' is reached (the point in the pressure-time curve that is preceded by a pressure drop of 0.15 atm. in 15 min., and succeeded by a pressure drop of not less than 0.15 atm. in 15 min.).



Proportioning pump shown by Lewa.

Arthur Pfeiffer, Wetzlar. This firm has manufactured rotary **high-vacuum pumps** for over 50 years. A number of products covering the whole range of high-vacuum technology was shown. Apparatus is made for freeze drying, vapour removal, degassing and impregnation. New developments shown include a two-stage pump which has a suction capacity of 300 cu.m./hr. and an end vacuum of 10^{-4} mm. Hg in series. By this combination, it is stated, a high-vacuum stage of high capacity is included, arranged to avoid condensation of vapours, and with exceptionally smooth operation, with pressure valves, condenser and a small preliminary vacuum stage with a pressure ballast vessel. It is pointed out that such combination systems are especially suited to all chemical processes in which a large evolution of vapours occurs. The example on show was a degassing plant for mineral oil; the high-vacuum stage of this unit is fitted with a three-stage self-fractionating oil diffusion pump. These pumps are manufactured with standardised capacities of up to 6,000 l./sec. to 10^{-4} mm. Hg. The evaporation and freeze-drying equipment was typified by a small model, which was, however, fitted with an automatic process cycle control.

Ludwig Pusl, Munich. An interesting **pocket *p*H meter,** measuring $13\frac{1}{2} \times 12 \times 6$ cm., is a battery-operated model with a direct-reading scale calibrated in *p*H. The 9-in. scale permits on-plant measurements to be made

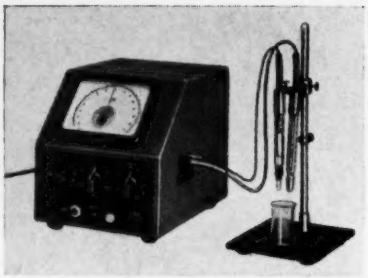
with laboratory accuracy, the makers point out. The instrument uses transistors and has a high internal resistance (10^{13} ohm), making it suitable for use with the glass electrode. The makers make a point that the use of transistors has a great advantage in respect of battery life as no filament current is required. The battery, which lasts eight weeks in normal usage, may be speedily changed by removing the base plate of the instrument, no solder or screw connections being used. The instrument is designed for use with a glass electrode, which is fitted with a cable with screw-locked connections; other electrodes, *e.g.* antimony or quinhydrone, may be supplied for special purposes.

In use, zero and temperature corrections are made by controls on the front of the case; the asymmetry potentials of the various types of electrode are compensated by the zero adjustment; and there is an adjustment to match the range to the electrode in use. Range: *p*H 2 to 12, ± 0.05 *p*H. Temperature correction: 0 to 100°C., continuously adjustable.

Q.V.F. Ltd., Stone, Staffs, England. The centrepiece of this stand was a 40-ft. flanged **glass tower** 18 in. in diameter. This was described as a typical example of the world's largest flanged glass tower. It was being shown as a general example of tower construction and can be used as a fractionating tower, wash tower or absorption column. An armour-plate glass tank of 220-l. capacity was shown in connection with the tower and from this a *Tungstone* all-glass pump was in operation. Air-operated, the pump has a capacity of 1,400 l./hr. at head of 30 ft. of water.

The same company showed a plant-scale unit of a steam-jacketed climbing-film operator constructed entirely in heat- and chemical-resisting borosilicate glass, while a further exhibit was a 10-plate bubble-plate column with two vapour and liquid sampler plates. The makers anticipate that this column will find extensive application for demonstration and instruction and that it will also be a most useful piece of apparatus in chemical engineering laboratories. They point out that it can also serve as a useful aid in training personnel who have to operate larger units of this type.

Rheinische Rohrenwerke A.G., Mülheim/Ruhr. A number of developments have been made in **corrosion-resistant steels** for chemical plant, based on the ferrite and austentite Sichromal steels. The high chromium



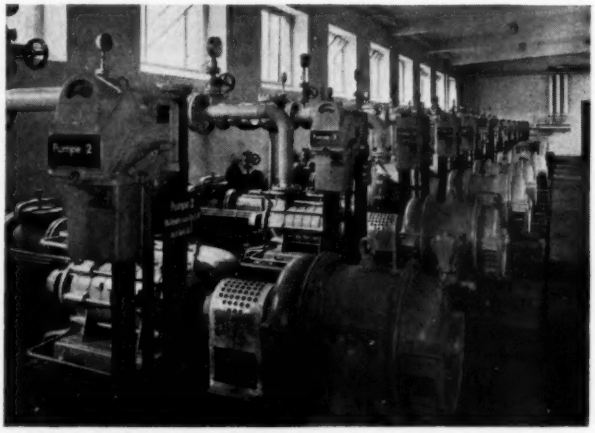
A.C. mains-operated *p*H meter (Ludwig Pusl).

content (>12%) of these steels is the basis of the corrosion-resistant properties, and these are enhanced by molybdenum, nickel and the carbide-forming elements tantalum, niobium and titanium. During the time of nickel shortage the Rheinische Rohrenwerke developed the use of nickel-free ferrite corrosion-resistant steels, in many cases as successfully as the austentitic Cr-Ni steels, it is stated. The austentitic Mn, Mn-Cr and Cr-Ni steels have been developed to give an exceptional strength at low temperatures, even for use with liquid air. It is further stated that Rheinrohr and Sichromal steels have been used extensively in clad coatings; surface treatment of steels, such as chroming or aluminising, has been developed as a means of increasing corrosion resistance while still retaining the mechanical properties of the base metal.

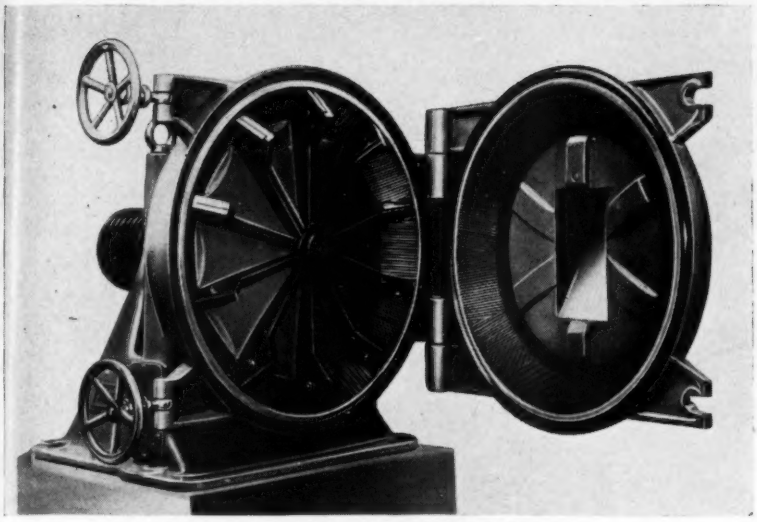
Special welding techniques and the use of newly developed materials have enabled satisfactory welds to be obtained with the aluminium-alloyed Sichromal steels; the Linde flux, *Ellira*, *Fusarc*, *Argonarc* and *Aircomatic* processes have been applied successfully to this problem. In addition to the normal range of heat-resisting steels, special steels have been developed for ammonia synthesis and for the oil industry, where hydrogen attack presents great problems; steels with a high chromium content (up to 18%) have proved most generally useful; the range of operating conditions is very large in such industries, and it is desirable to be able to meet these specifications with the lowest possible number of special alloys.

Sartorius Werke A.G., Göttingen. This company claim to be the world's largest manufacturers of **precision balances** and to be responsible for the introduction of air damping, mechanical manipulation of weights and projection reading. Many new types of instruments for fine weighings, reflecting changing and progressive design were exhibited. The display included twin-arm beam *Selecta* balances and some interesting new features were seen; for example, an electronic recording device has been introduced into these instruments. In the new *Constanta* balance the cylindrical metal housing and the method of weight application of *Selecta* balances have been employed to encase and operate the popular classical types of instruments such as the DP 3, the DP 2, etc.

Another interesting new model was the analytical balance for series weighing against a pre-set weight. The sample is agitated by means of a photo-electric device on to the weighing pan until equilibrium has been achieved. The sample is released from the pan into one of six crucibles, which revolve on a roundabout under the weighing pan. The crucible is then extracted from the roundabout and the next weighing is automatically proceeded with. A sedimentation balance was also shown which is especially designed



Voigt & Haeffner automatic oil-immersion switches in a pumping plant.



A turbo mill exhibited by Ludwig Pallmann.

for recording the rate of sedimentation and for the determination of particle size to an accuracy of 1μ.

A good deal of interest was aroused by the differential thermo balance, after a design by Prof. De Keyser. This instrument records the change of state of specimens under the influence of temperature over timed periods.

Perhaps the most significant development was that shown in the *Electrona* balance. The mechanism of this instrument is contained in a magnetic field, and changes of weight of the sample are electronically recorded to an accuracy of 1 μg. This instrument, together with the newly designed MPR 5 micro balance and the model T 11 micro torsion balance, places at the disposal of scientists completely new facilities for accurate precision weighing, the company state.

Siemens & Halske A.G., Karlsruhe. **Electrical apparatus** exhibited included thermocouples with improvements in the insulation of the thermocouple junction which, it is stated, result in a reduction in heat losses along the elements to the head of the instrument. A manometer for low gas pressures operates with a diaphragm attached to the coil in a magnetic field; the current through the coil from a magnetic intensifier is adjusted to give minimum induction so that the equilibrium pressure on the diaphragm is balanced by the current in the coil. This arrangement is stated to be especially suitable for automatic controlling instruments. A rotary flowmeter, constructed of plastic, has a magnetic linkage with the recording mechanism. An electrical hygrometer is shown, based on the principle of passing a current through a solution of lithium chloride on a glass-fibre fabric. The temperature at which the solution loses all its water as a result of the electrical heating depends on the moisture content of the surrounding gas.

Two other regulators shown are for boiler plant use. Steam pressure is measured on a gauge coupled to a resistance element telemeter controlling the firing; a similar instrument controls the steam temperature, using a resistance thermometer.

Two new proportioning flow controllers were shown, in one of which the differential pressures across nozzles or orifice plates in the two streams of gas or liquid operate pneumatic valves to control the proportional flow. This instrument is claimed to be very stable over a considerable range of absolute pressures in the two flow streams. A controller with a ring flowmeter designed for small flows of viscous liquids operates by transferring the rotation of the flowmeter to the control gear with a screw differential; pneumatic control of the flow maintains a constant ratio between the liquids. This instrument is stated to be suitable for controlling the mixing of three or more liquids.

'Selecta' balance, shown by Sartorius.

Ströhlein & Co., Düsseldorf. The Oelsen-Abresch apparatus for the coulometric micro-determination of C and S (improved model) has a more exact end-point arrangement, with a sensitive moving-coil galvanometer, a timing device sensitive to 0.1 sec., and pressure controls, with a new titration device for carbon determinations and a supplementary device for sulphur determinations in the same apparatus under operating conditions.

A **magnetic stirrer** with electrical heating (D.G.M. application) was shown. This model is fitted with a screwed stand, and the energy regulator gives a continuous range of 60 to 600 w. The stirrer, which is of glass with *Teflon* bearings, may be regulated from 100 to 1,000 r.p.m. and is firmly driven by a high-intensity magnet.

The **potentiometric analysis apparatus,** Krupp model, was one of this company's exhibits. This apparatus, for the determination of Cr, V, Mo, Ni and Ti, was designed by P. Dickens and G. Thanheiser, of the Kaiser Wilhelm Institute for Research on Iron and Steel, and was later improved in the chemical laboratories of Friedrich Krupp A.G. It comprises a stirrer stand, electrode assembly, the measurement unit and accumulator. Another apparatus shown was the Gerke high-capacity apparatus for the volumetric determination of carbon in steel and iron (D.G.M.). This consists of two special burettes, with an automatic end-point determination, on a metal assembly and is capable of 30 to 40 analyses per hour. The operator works in a sitting position and no lifting of a levelling bottle is required.

There was also a small dust sampler, Ströhlein/Lurgi type, for waste gases, stack gases, crude and purified gases, with electrical heating.

The Goldschmidt extraction apparatus, Kohnle model, is a combined apparatus for the rapid determination of water, thickeners and fillers contents of emulsions.

An ether extraction apparatus was shown (Max Planck Institute model) for trace analysis. This has two units

with stirrers for light and heavy extracting liquids and a unit for distillation of residues. A further exhibit was the Feichtinger micro thermostat. Of this instrument, it is stated that, in spite of the simplified design, the principle of thermal equilibrium is effective for obtaining a constant temperature over the range 18 to 40°C. The Feichtinger micro gas analyser is another apparatus designed for rapid precision analysis of gases, especially of traces in very small quantities of the order of 0.05 to 2 ml. There are no valves or other sources of inaccuracy, dead space being avoided, and a combustion furnace is incorporated. Readings are by a micrometer, exact to 1 cu. mm., estimated to 0.2 cu. mm. The equipment is built on the unit principle, with various adsorption sections.

H. Strunck & Co., Cologne-Ehrenfeld. This firm's exhibit comprised a range of **ampoule filling and bottling machines.** Ampoule cleaning machines, for hand or automatic operation, have capacities of 2,000 and 4,000 per hour respectively. A rotary bottle-washing machine has a capacity of 1,500 bottles/hr. and gives a wash with three successive liquids and a final drying with compressed air; the liquids are returned for re-use. Vacuum fillers were shown and a fully automatic combined washing, filling and closure machine. This has 20 positions and an hourly capacity of 12,000 bottles; it fills under vacuum and can use various types of closure.

An automatic, sterile, ampoule-filling and -sealing machine, drawing off the glass to a seal, has a capacity of up to 4,000/hr. Packaging machines with automatic feed and output transport were shown, for all types of round objects, including ampoules of up to 50-mm. diameter, with a capacity of 10,500/hr., and also a packaging machine for up to 5,000/hr. for flat flasks. Another exhibit was an automatic flanging machine, with exact centring and a large range of height adjustment, with a capacity of 3,000/hr. Also shown was an automatic wadding packer, for tablet tubes and bottles, working from a skein, with an hourly capacity of 3,000 units.

Voigt & Haeffner A.G., Frankfurt-am-Main. This firm's exhibits included a range of **electrical switchgear** for the chemical industry, and various types of heating elements and infra-red heaters. Ring cable switch units suitable for use in corrosive and moist atmospheres contain two separators and an overload release. By this means the unit may be isolated from one section of the ring cable or connected to alternative feeders as required. A bridging switch was shown for use in short-circuiting, single, electrolytic baths operating in series; this switch is designed for very high currents at a low voltage. Oil-filled circuit breakers, also shown, are constructed with a case giving protection against moisture, dust and mechanical damage; the oil filling forms a further protection against corrosive gases. These circuit breakers are available to comply with safety regulations for explosive atmospheres. A range of similarly explosion-proofed switchgear is also manufactured.

Air circuit breakers of various capacities were also shown, fitted with thermal relays. Relays fitted with a temperature compensator are adjustable in the proportion 1 : 2 up to 8 amp. for the closed- and open-circuit positions. Tube heating elements are available in a variety of sizes, some with a high loading and very small dimensions.

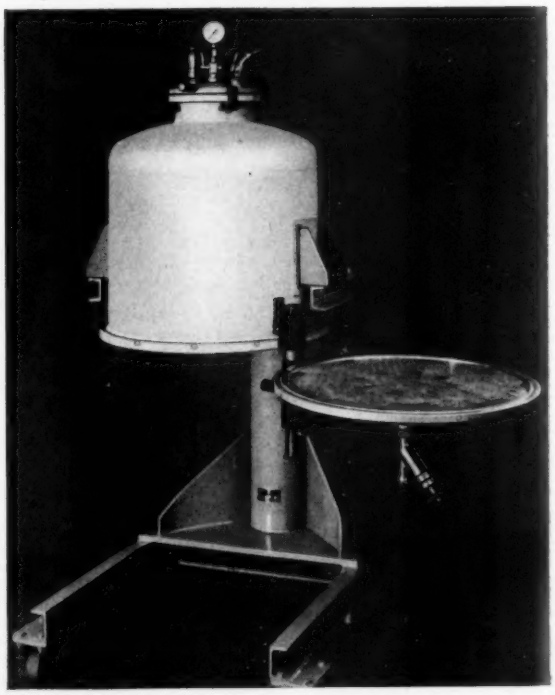
The standard heating element now has a diameter of 8.2 mm. instead of 9 mm., and elements of 5-mm. and 30-mm. diameter are also available. The former are highly loaded, up to 16 w./cm., and are available in 1-m. lengths; they may be bent to sharp radii (10 mm.). The larger size can be loaded to 10 kw./m. in heating liquids.

An infra-red heater was shown, consisting of a tunnel of parabolic reflectors. This type of heater is stated to have numerous applications for drying, impregnation, evaporation, polymerisation, etc., and is very easily handled by virtue of its solid construction and small space requirement.

European Federation of Corrosion

A contribution towards closer European co-operation in the field of science and technology was made two years ago by the creation of the European Federation of Chemical Engineers. A further step towards this goal has been taken with the formation of the European Federation of Corrosion on May 19, 1955, on the occasion of the Convention of Chemical Technology in Frankfurt-am-Main, when 33 technical and scientific societies from eight European countries (Germany, France, Italy, Luxemburg, Austria, Sweden, Switzerland and Spain) met to discuss the phenomena and causes of corrosion. Norwegian and Spanish societies which were unable to attend these meetings also declared their willingness to collaborate.

The object of the new Federation is to foster European collaboration in the field of research on the means of combating and protecting materials, for the benefit of all concerned.



Single-sheet filter shown by Seitz-Werke GmbH.

Chemical Engineering Invention

RECENT BRITISH PATENT CLAIMS

Wet process of refining copper

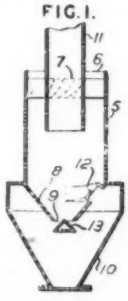
Nickel-copper mattes having a sulphur content insufficient for binding the metals as sulphides, say 20%, are preferably first subjected to prolonged heating, *e.g.* at 500°C., to promote a growth of grain and a demixing of the phases and, after comminution, the fraction consisting predominantly of metallic nickel and copper is mechanically separated, *e.g.* by magnetic treatment, flotation, windsifting or sieving, and is treated with a nickel-dissolving agent such as sulphuric, hydrochloric, nitric or organic acid, or salt solutions, *e.g.* of copper sulphate or ferric chloride. The metallic copper produced carries any noble metals present.

Any copper passing into solution may be precipitated by treatment with a further amount of the metallic fraction. The metallic fraction may also be used for purifying nickel salt solutions obtained otherwise, precipitating all metals nobler than nickel.—698,162, *Badische Anilin & Soda-Fabrik.*

Dust separators

This invention is a dust separating apparatus, comprising a bunker 10, and a cyclone having a substantially cylindrical upper part 5 and a conical part 8 with an included angle between 60 and 90°. The lower part has an opening 9 giving access to the bunker, and the wall of the cyclone near to

FIG. 1.



the junction of the upper and lower parts has one or more tangential slots 12 for discharge of dust to the bunker.

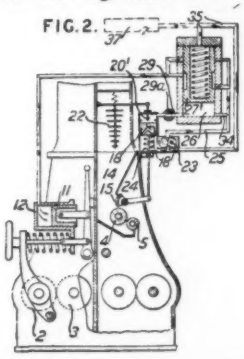
Particle-laden gas enters an axial inlet 6 having whirl-producing blades 7, and cleaned gas is discharged through a pipe 11. A baffle 13 provided opposite the opening 9 may be vertically adjustable to close the opening during separation. The slots may be formed in the cylindrical part 5 and ducts provided to lead the dust to the bunker.

In a modification (not shown), the separator has a tangential inlet, a slightly conical upper part, and the baffle is dispensed with.—695,347, *Bureau van Tongeren Naamlooze Vennootschap.*

Roller mill regulating device

A regulator for roller grinding mills comprises a piston 11 for moving a roller 2 relative to a roller 3, and a piston 18 for controlling a feed gate 15 at the outlet of a feed hopper 14. A device 22 detecting the amount of material flowing into the hopper

FIG. 2.



actuates a valve 20^1 controlling an exhaust port 18^1 in the piston 18. Pressure fluid is supplied by a pump 23 through lines 25, 34, chamber 26, line 29 to the space above the piston and, when the valve 20 is urged downwardly, pressure builds up in the space and the chamber 26 to move a piston valve 27 to connect the line 25 to the cylinder 12 containing piston 11.

The dimensions of piston 18 and spring 24 are so arranged that the piston 11 moves before the piston 18. If the pressure fluid is compressed air, a whistle 37 is connected to the return line 35 and, when the valve 27 is urged to its lower position due to lack of material in the hopper, an audible warning is given. The feed rollers 4, 5 are moved into and out of gear mechanically in dependance on the position of the movable grinding roller.

A cock 29*a* in the line 29, when closed, causes the grinding rollers to be engaged and feed rollers to be moved into gear whereby the hopper may be completely emptied through the narrow gap between the gate 15 and roller 4, which gap is present when the gate is closed. — 698,085, *Buhler Geb.*

Treating carbon

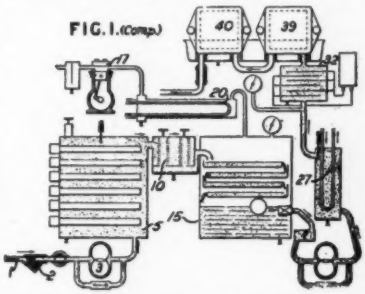
Carbon for the chromatographic treatment of carotene-containing oils is freed of oxygen by (1) treatment at a normal or slightly elevated temperature with a reducing agent or (2) heating to 350°C. or above in an oxygen-free gas such as hydrogen, nitrogen, steam or carbon monoxide or dioxide. Suitable reducing agents are hydroquinone, formic acid and sodium sulphite, dissolved in benzene, ether, alcohol or water.

After such treatment, the reducing agent is removed by washing with benzene, and the latter expelled by a fat solvent such as petroleum ether, acetone or ether. Examples are given. —691,924, *Lever Bros. and Unilever Ltd.*

Electrostatic precipitation

Fine particles are separated from dehydrated oil by ionising with high-voltage a.c. to form agglomerations and then filtering. As shown, dirty oil (*e.g.* from a steam turbine) passes through (i) a coarse filter 2 and is pumped by a pump 3 into a tank 5 where it is warmed to 70°C. by electrostatically controlled immersion heaters, (ii) an edgewise filter 10 into a dehydrating tank 15 which is maintained under vacuum by a pump 17, the water

FIG. 1.(Comp.)



vapour being separated out by a condenser 20, and (iii) an oil cooler 27 to solidify partly soluble asphaltenes and into an agglomerator 32. The agglomerated particles are removed by filters 39, 40.

The agglomerator comprises an insulating cone through which oil enters at the apex and is directed tangentially

round the surface over pairs of electrodes on the lower part of the cone energised at 50 to 70 kv. a.c., having a frequency of 1 to 400 c/s. The supply is obtained from a motor-driven Wimshurst machine and reversing switch enclosed in a container with an inert gas under high pressure. Alternatively, an induction coil may be used, according to the Provisional Specification.—698,900, *O. E. Nekolla.*

Acetylene generation

Acetylene is generated by decomposing calcium carbide with a minimum of water and is freed from dust containing alkaline-earth metal compounds by washing in a tower or other apparatus packed with filling elements with water containing a small amount of an acid capable of dissolving the alkaline-earth compounds. The use of hydrochloric acid is preferred and the amount used, 0.1 to 1 g./l., is such that the used washing water is slightly alkaline in reaction.

Used water from the washing of acetylene with a dilute aqueous chlorine solution which usually contains a small quantity of hydrochloric acid may be used.—692,583, *Akt.-Ges. fur Stickstoffdunger.*

Mixing acid and alkali

A method is described of controlling a mixing process in which acid is added to an aqueous alkaline solution to reduce the alkali content of the solution. Methyl orange or some other indicator responsive in its colour to acidity or alkalinity is added to two samples of the mixture of solution and acid. To one of these samples such an amount of additional acid is added that, if the mixture is satisfactory, the sample becomes slightly acid and so in the presence of the indicator changes colour. The proportion of acid mixed with the solution is corrected if the colour of either sample is not that corresponding to ordinary mixing.

In a process of blending alkaline water with acidic water to produce a mixture of substantially constant alkalinity, two samples are continuously bled from the mixture and methyl orange or other colour indicator is added to each sample.

A further quantity of acidic water is added to each sample, the further quantities being different from each other so that, if the blending is being correctly performed, one sample will just be rendered acid and the other sample will have its alkalinity reduced nearly to the neutral point, and in the presence of the colour indicator the samples will be of different colour. The blending proportion of the mixture is corrected upon the colour of either sample changing.

The samples may be used to control two photo-electric devices responsive to the two colours in that, if either changes, the device in question will provide an electric impulse for operation of a relay by which the blending proportion is corrected. — 699,909, *Permutit Co. Ltd.*

Ball mill

In a vibrating or oscillating ball mill 2, the material to be ground and an air stream are fed to the mill through tubes 5, a jacket 3, and one or more holes or slots 4. The dust-laden air passes through an outlet 6 to a separator 7 from which insufficiently ground material passes back to the mill through a conduit 8. The ground material passes from the separator to

FIG. 1.

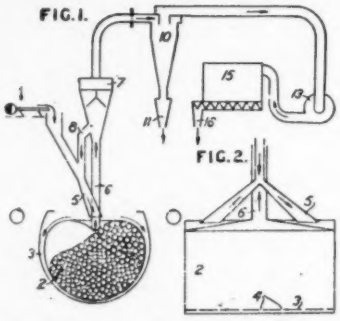


FIG. 2.

a cyclone 10, the separated ground material being removed at 11 and the separated air passing through a suction fan 13 and a zone 15 from which the remainder of the ground material is removed at 16.

The mill may oscillate alternately in clockwise and counterclockwise directions, in which case the upper surface of the mill is heart-shaped. Further, a number of mills, actuated by a common drive, may be connected to one separating system.—698,660, *Naamlooze Vennootschap Tema.*

Germany Makes Chemicals from Natural Gas

Following the example of other countries such as the United States and Canada, Western Germany is developing a new branch of chemical industry based on natural gas. According to an account that appeared in *Erdöl und Kohle* of March, 1955, production of chemicals from natural gas in Germany is still small—about 100 million cu.m. of gas are used there annually compared with 200,000 million cu.m. in the U.S.—but an intensive search for new sources of natural gas is going on, particularly in Bavaria, and this new branch of Germany's chemical industry seems likely to assume some economic importance.

Germany's use of natural gas as a raw material for the manufacture of chemicals began in 1938, when gaseous hydrocarbons evolving from mineral oils stored by nature in porous strata, were for the first time collected at Bentheim near the Dutch frontier. The gas, which contains over 90% of methane, is freed from carbon dioxide and water vapour and sent to the chemical works at Hüls, near Düsseldorf, through a pipeline some 50 miles long.

At Hüls the methane is converted by the electric arc process into acetylene. The acetylene is then converted into monochloroethylene or vinyl chloride according to the equation :

$$CH : CH + HCl = CH_2 : CHCl,$$

and the product of this reaction yields on polymerisation, under the action of controlled heat and suitable catalysts, polyvinyl chloride (PVC).

But not all the acetylene made at Hüls is converted into PVC. Some is made to combine with prussic acid to form the nitrile of acrylic acid :

$$CH : CH + HCN = CH_2 : CHCN,$$

and acrylonitrile yields on polymerisation polyacrylonitrile. This is the raw material of the German *Pan* fibre, the equivalent of the American *Orlon.*

Another process of using acetylene on an industrial scale is based on the chemical reaction between two acetylene molecules to form vinyl acetylene:

$$2CH : CH = CH_2 : CH.C. : CH$$

By addition of hydrogen chloride vinyl acetylene is converted to chloroprene $CH_2 : CH.CCl : CH_2$, which on polymerisation yields the oil-resistant synthetic rubber Neoprene.

In 1952 a further source of natural gas was discovered at Pfungstadt near Darmstadt. This gas, which contains 98% methane, is sent with a pressure of 66 atm. through a pipeline of 4 in. diameter over a distance of 25 miles to the Farbwerke Höchst A.G., where most of the gas is chlorinated to yield a valuable series of non-inflammable organic solvents.

Natural gas collected at Rehden and sent through a pipeline 18 miles long to Osnabrück is mainly used as a fuel.

Progress in Water-Pollution Control

Radioactive wastes and industrial effluents

THE developments now taking place in the generation of electricity from atomic energy and in the use of radioisotopes will greatly increase the quantities of radioactive waste materials produced. The choice of sites for generating stations and for other plants discharging radioactive wastes might depend on the amounts of active substances that can be discharged to a river without precluding the use of the water for domestic supply or for industrial, agricultural and other purposes.

This possibility is raised in the annual report* of the Water Pollution Research Board (D.S.I.R.) for 1954, and it is further pointed out that among questions to which answers are required are whether the substances are adsorbed on mud and silt, whether they are taken up by plants and animals and whether adsorbed material is released at a later date. The Board considered that this work should have priority and it is hoped to begin the investigation during 1955 in a pilot laboratory of the Board's new laboratory, which was occupied during the year, at Stevenage.

Progress was made in the survey of the Thames estuary, in investigations on the effect of pollution on fish and in work on the treatment of water, sewage and industrial waste waters.

The laboratory's work on the treatment of industrial effluents usually starts as a result of requests for advice and help from particular industries. There are, however, certain basic processes which require much further study and, of these, the Board have suggested that biological treatment, under both aerobic and anaerobic conditions, should be given an important place in the programme.

It was reported last year that some cyanides could be destroyed by biological action in a percolating filter; the organism responsible has now been isolated and has been found to be an *Actinonycete*. To determine whether biological destruction would be a practicable method for removing cyanide from mixed plating wastes, a filter was supplied with a solution of potassium cyanide and of the complex cyanides of the metals commonly plated from cyanide solution (zinc, cadmium, copper, etc.). The results were satisfactory.

*'Water Pollution Research, 1954,' H.M.S.O., 3s.

Treatment of cotton kiering liquor

Experiments on anaerobic digestion of partially neutralised waste liquor from the kiering of cotton were continued, using the pilot plant described in the last report. The digestion chamber in this plant had a capacity of about 50 gal. and was maintained at a temperature of 30°C. The liquor to be digested was admitted at the bottom of the digester and was drawn off through a trapped outlet at the top. Active sludge put in the digestion tank at the beginning of a series of experiments was kept in intimate contact with the liquor passing through the tank by means of a slowly rotating paddle stirrer.

The results obtained with the pilot plant show that anaerobic digestion would be a possible method for reducing the B.O.D. of cotton kiering liquor, provided that the *p*H of the liquor was first brought down to a value of about 8.5. Although the proportion of oxygen-consuming matter removed fell off, the actual amount removed continued to increase as the load applied to the digester was increased up to the highest load tried.

It was calculated that a digester would occupy less space than a percolating filter that would effect a similar degree of purification. An important point to note, also, is that the undiluted liquor could be dealt with by anaerobic digestion, whereas for treatment in a percolating filter the liquor had to be diluted considerably with water.

Gas works liquors

Experiments have been continued on the treatment of spent liquor and retort-house liquor from Hinckley gas works. The spent liquor contains a relatively high concentration of monohydric phenols; the crude retort-house liquor contains about half this amount, but is rich in ammonium chloride and ammonium thiocyanate and it also contains comparatively large amounts of 'higher tar acids.'

The experiment reported last year was continued: one of the percolating filters at Stivichall (filter *A*) treated settled domestic sewage to which had been added, by volume, 1% spent Hinckley liquor and 0.1% Hinckley retort-house liquor; and the other filter (filter *B*) treated similar sewage to which only 1% of spent liquor had been added. The percentages are calculated on the dry-weather flow of the sewage. As before, the B.O.D. of the effluent, both as it left the humus tank and after filtration in the laboratory, was of better quality from the filter treating the spent liquor only, than from the filter treating the spent liquor and the retort-house liquor.

In April 1954 another experiment was started in which to the settled sewage treated in filter *A* was added 0.1% of retort-house liquor and to the sewage treated in filter *B* was added 1% of spent liquor, both from the Hinckley gas works. There was no substantial difference between the quality of the effluents from the two filters. The period of the experiment was too short to give decisive results, but it is understood that the work is to be continued by the Gas Council.

Previous work with small-scale filters at Stivichall, in which had been treated sewage containing various fractions of crude gas liquor from Leeds, had shown the importance of higher phenols and of carboxylic and humic acids, the precise composition of which is not at present known but all of which can be extracted with a suitable solvent. The greatest effect on treatment of the sewage, however, was given by the residue of the gas liquor after solvent extraction. This residue contained all the ammonia, thiocyanate, thiosulphate and chloride, besides unidentified substances with a small but significant permanganate value. It was thought that the ammonia in the fraction was an important constituent.

Experiments have emphasised how variable the results may be of treating the same liquid in a series of small filters operated as far as possible under identical conditions. It is thought that before proceeding further with work of this kind much more information is required on the inherent variability of model filters and it is proposed to carry out an experiment in which 40 similar filters will be operated under conditions as nearly as possible the same, so that the extent of the variability can be examined by statistical methods.

Removal of fluoride from water

Some experiments have been begun on the removal of fluoride from water by absorption by activated alumina; this method has been used in America and appears to be the most promising of the several methods which have been tried. The absorption column

(*Concluded on page* 278)

Personal Paragraphs

★ **Sir Geoffrey Heyworth,** chairman of Unilever Ltd., has been created a baron, in the Birthday Honours list, for public services.

★ **Dr. Alexander Fleck,** chairman of Imperial Chemical Industries Ltd., becomes a K.B.E., for services to the Ministry of Fuel and Power.

★ Executives of Coalite & Chemical Products Ltd. who have recently been appointed to the board are **Mr. A. Goodsell** and **Mr. G. S. Pound,** both of whom joined the company in 1927 (Mr. Pound was for 17 years in charge of the refinery), and **Mr. J. H. Orr,** who has been sales manager since 1950.

★ Edwin Danks & Co. (Oldbury) Ltd. announce the retirement of **Mr. W. F. Johnstone,** their chief engineer. He is succeeded by **Mr. H. McAndrew,** who joined Babcock & Wilcox Ltd. in 1924, being engaged on the design and detailing of the first high-pressure boiler installed in England (Bradford). He was appointed deputy chief engineer of Edwin Danks in 1952.

★ Blaw Knox Ltd. announce that **Mr. John Chaplin** has joined the executive staff of the company's chemical plants department. This department was inaugurated in 1954 to manufacture in Britain the *Buflovak* range of equipment which was previously only available from America.

★ Hathernware Ltd. announce that, following the retirement of **Mr. C. E. Taylor,** the vacancy created on the board has been filled by the appointment of **Mr. N. Tanner.**

★ **Mr. T. E. Potts** has been appointed a director of the British Oxygen Co. and chairman of British Oxygen Gases Ltd., the new subsidiary of the British Oxygen Co., which is to conduct all trading operations in industrial and medical gases and equipment as from October 1.

★ **Mr. G. W. Lake** has been appointed production director of British Oxygen Gases Ltd.

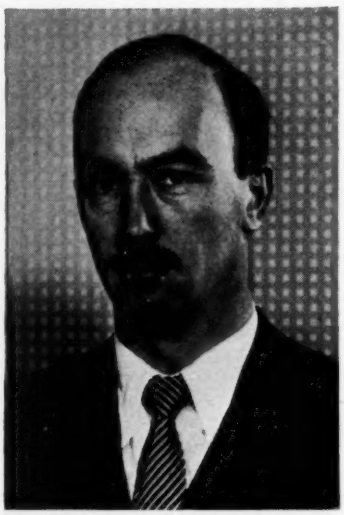
★ **Mr. R. B. Whalley** has joined the staff of Metal & Pipeline Endurance Ltd. as chief welding engineer. He was formerly welding engineer for the Central Electricity Authority.

★ **Mr. J. M. White,** lately chief sales engineer, has been appointed to the London office of George Kent Ltd. on return from his present visit to Canada. **Mr. J. Tham** has been appointed chief sales engineer in succession to Mr. White.

Mr. Harry S. Broom, 80 years old this month, started work as a 5s.-a-week engineering apprentice, built up a £1-million business.

★ **Mr. Howard R. Huston** has retired from his position as vice-president and director of American Cyanamid Co. Mr. Huston will serve the company as a consultant.

★ **Mr. Robert Q. Wilson** has been appointed United Kingdom representative for Battelle Memorial Institute,



Mr. Lindsay Burns, Jun., who, as reported last month, has been appointed joint assistant managing director of the Balfour Group.

the industrial research organisation, and will be in charge of the Institute's recently registered office in London. His fields of specialisation have been chemical engineering and minerals beneficiation. **Dr. H. E. Z. Gordon,** who until recently has been active as Battelle's U.K. representative, is now devoting himself to the interests of Battelle Development Co. Ltd., of which he is general manager.

★ **Mr. L. K. Brindley,** M.B.E., has been elected deputy chairman of the boards of the Mond Nickel Co. Ltd. and Henry Wiggin & Co. **Mr. G. Archer,** C.M.G., has been elected managing director of Mond Nickel.

★ **Mr. I. A. Bailey** is moving his headquarters from Birmingham to London where he will continue as a director of Mond Nickel and as managing director of Henry Wiggin. **Dr. L. B. Pfeil,** O.B.E., has relinquished the managership of the development and research department in order to devote himself more fully to directorship responsibilities. **Mr. R. A. R. Hill** has been elected a director of Mond Nickel and to the offices of comptroller of both the companies concerned. **Mr. F. B. Howard-White** has been elected a director of Henry Wiggin and secretary of both companies. **Mr. J. O. Hitchcock** has been elected a director of Mond Nickel and appointed sales director. **Mr. F. Dickinson** has been appointed manager of the development and research department.

Mr. A. P. Hague continues as a director of the two companies and **Dr. A. G. Ramsay** as a director of the Mond Nickel Co., resident in south Wales.

★ **Mr. Harry S. Broom,** chairman of Broom & Wade Ltd., celebrates his 80th birthday this month. At the age of 15 he was apprenticed to an engineering shop at a wage of 5s. per week. He later obtained a post at the engineering works of Davey, Paxman & Co., where he was to meet his future partner, Jethro Wade. Their business started in a small workshop in a cornfield; it now occupies 14 acres, employs a total of 1,400, has subsidiary companies and agents all over the world and has an authorised capital of £1 million.

★ **Mr. S. H. Hole** was recently elected a vice-president of the Junior Institution of Engineers.

★ **Mr. D. J. Tow** of Head Wrightson Processes Ltd., recently became chairman of the Graduates Section of the Institution of Chemical Engineers.

Plant and Equipment

Ester plasticisers

British Industrial Solvents have recently announced new ester plasticisers in the *Bisoflex* range. *Bisoflex* 102 is essentially triethylene glycol dicaprylate and is of interest as a plasticiser for butadiene-acrylonitrile copolymers such as *Hycar OR*15. According to the makers, it is characterised by very good low-temperature properties, adequate compatibility with these polymers, a measure of oil resistance and ageing properties substantially equivalent to dioctyl phthalate in these compositions. It is stated that *Bisoflex* 102 is also useful in PVC compositions, more particularly as a means of improving the low-temperature performance of the conventional phthalates. It gives PVC pastes of low viscosity and good stability. It is further claimed that it shows excellent compatibility with polystyrene and may prove of interest in this field.

Bisoflex 102*A* resembles *Bisoflex* 102 in most of its properties, though it has a very slightly inferior low-temperature performance. Based on mixed fatty acids which have recently become available, rather than on relatively pure caprylic acid, it is likely to prove an economically attractive alternative to *Bisoflex* 102.

Another plasticiser for PVC and for butadiene-acrylonitrile rubbers is *Bisoflex* 103. In its general effect on the mechanical properties of PVC compounds it resembles dioctyl phthalate, but is characterised by an improved low-temperature performance, which lies midway between those of D.O.P. and dioctyl sebacate.

Bisol acetoacetarylidides provide a range of intermediates for the production of high-quality organic pigments such as the Hansa yellows.

Air heater

The type I.T.G. gas-fired air heater is a simple and compact source of heat for applications where the products of combustion may be mixed with the air to be heated. It can be used with ovens, drying kilns, rotary and spray dryers and similar equipment for raising air temperatures up to 500°C., and for working with an induced draught of 0.5-in. water gauge or over.

A very small proportion of the volume of the heater is occupied by the combustion zone, which is surrounded by an insulating layer of diluting air. The balance of the heater volume acts as a mixing chamber for the diluting air and the products of combustion. Refractories are not necessary in the combustion zone, and the heater is lined internally with an insulating refractory to conserve heat. The diluting air maintains the inner face at a comparatively low temperature which is not much greater than the working air temperature.

Hypact burners are used. These, the makers state, are extremely simple and have no moving parts, require no high-pressure air or pre-mixing, and have great flexibility with a high turn-down ratio without readjustment of the primary or secondary air supplies.

An inlet port is provided on the front plate of the heater to take re-circulated air so that it may be operated on a closed circuit, with consequent increase in thermal efficiency. Pre-set control on the front plate of the heater is a simple hand-operated air slide, which provides the entry of diluting air and controls the primary and secondary air velocity around the burners.

The heater is supplied with approved flame failure and safety equipment. Electric ignition is also provided when required, and automatic air temperature control may be fitted. Dunford & Elliott (Sheffield) Ltd. are the suppliers.

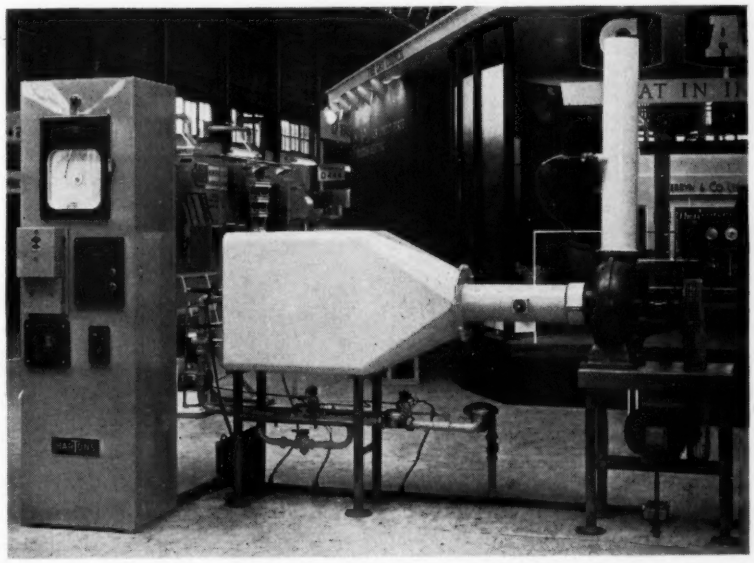
Ni-Cr alloy for furnace resistors

A new grade of nickel-chromium alloy for high-temperature furnace resistors is being produced by Henry Wiggin & Co. Ltd. This is a modified 80/20 nickel-chromium alloy intended for use as a heating element in electric resistance furnaces and for operating in the temperature range 1,100 to 1,250°C.

Developed as a result of extensive work carried out in the research laboratories of the Mond Nickel Co. Ltd., *Brightray* 'H' is now in production by Henry Wiggin in the form of rod, wire and strip. It has been under test in the laboratory for several years and has proved successful in several metallurgical heat-treatment furnaces and for high-temperature firing of pottery.

Oxidation resistance of the new alloy at temperatures above 1,100°C. is claimed by the makers to be better than that of the standard 80/20 nickel-chromium alloy. Laboratory tests on strip 0.88 mm. thick by 14 mm. wide and on rod heated continuously in air to 1,250°C. gave lives of over 1,000 hr. This, it is stated, shows a considerable improvement over the life which can be obtained with the standard 80/20 nickel - chromium alloy in similar conditions.

The specific electrical resistance of the alloy at room temperature is 126 to 130 michrohms/sq.cm./cm. This increases by 3.6 to 4% as the temperature is raised to about 450°C. and



The direct fired air heater designed by Dunford & Elliott (Sheffield) Ltd. is seen here on the Gas Council's stand at the British Industries Fair.

decreases by 6 to 9% between 450 and 900 to 1,000°. As the temperature is further increased the specific resistance rises slightly, but up to 1,300°C. remains less than the value at room temperature.

High-efficiency air filter

The dust separation provided by the normal high-efficiency filter is inadequate for certain purposes, such as those encountered in photographic, pharmaceutical, bacteriological or atomic energy work. In such cases, particles between 0.1 and 5 microns can cause trouble comparable with that produced by coarser matter and, to meet the new requirements, special high-efficiency filters have been devised.

Among these are filters employing deep high-efficiency fibrous 'laps' as media, which are capable of extremely high dust-retention efficiency. However, although such filters, usually taking the form of cylindrical or rectangular-section canisters, can possess the ultimate in performance characteristics, a snag sometimes arises in that they tend to be bulky and relatively costly. Also, metallic parts are usually involved and, in some applications where incineration of the fouled unit is the best method of disposal, this is quite a serious objection. At the same time, the resin-wool variety of filter, which is by far the most economical, possesses the disadvantage of falling efficiency with use.

Search was therefore made for an alternative filter arrangement which, though perhaps not possessing the same ultimate performance as the canister, would yet be more than adequate for many applications and also have the advantage of construction from cellulosic materials, such as wood and paper, which could be readily destroyed by incineration.

It is stated that these requirements can now be met with a new filter, the performance of which has been made possible by recent developments in paper manufacture. These have enabled advantage to be taken, in a compact form, of the principles employed in the high-efficiency 'lap' canisters. The secret is to suspend or disperse extremely fine asbestos fibres in a matrix of relatively coarse cellulose fibres; in this case, from esparto grass. By careful control of manufacturing technique, it is claimed, such a composite paper can be given a remarkably high dust-retention efficiency and yet have very low flow-restriction characteristics.

The inherent thinness of the paper enables an extremely large filtration area to be accommodated in a very small space, and it has proved possible to rate a filter panel 24 in. by 24 in. by 11½ in. in size at 1,000 cu.ft./min. for an initial flow restriction of under 1.5 in. water gauge. The shallower 24 in. by 24 in. by 5⅞ in. panel has even better characteristics and is rated at 500 cu.ft./min. at 1-in. water guage.

Efficiency against a methylene blue or di-octyl phthalate dust cloud is stated to be better than 99.95% initially (*i.e.* 0.05% penetration) and, in common with all purely 'mechanical' filters, efficiency rises steadily as dust accumulated on the paper. This penetration is greater than that achieved with the 'lap' canister, but is sufficiently low for most applications demanding super-efficiency filtration.

Vokes Ltd. are the suppliers.

Pressure-transient recorder

In a new design utilising interferometric optical principles, the new Beckman & Whitley model 216 pressure-transient recorder, it is stated, provides the capability of recording short-term pressure variations over a very wide series of pressure ranges. The film record produced is suitable for rapid analysis and data reduction —a first approximation of pressure being available by the simple counting of the number of fringes.

In application, the instrument can be utilised in three ways: (1) exposed to free air manifestations, (2) attached directly to a pressure vessel or (3) fed by a hydraulic line from the pressure source. Two units comprise the system: the combined transducer, optical system and camera with 2-millisecond timing-pip system, all housed in a small case 15¾ × 9¼ × 7¼ in. and weighing 25 lb.; and the control unit (housed in a standard 19-in. rack unit 7-in. high and 8½ in. deep, weighing 25 lb.), which can be located remotely from the transducer. Complete control is exercised from this point, including the camera drive motor, dynamic braking system and the monochromatic light source which illuminates the transducer.

Since the instrument essentially measures the displacement of the transducer diaphragm, it is additionally adaptable for the measurement of any physical phenomena which can be translated into lineal motion, *e.g.* changing dimensions of a crystal under the action of a potential difference, magnetostriction effects on a body placed in a varying magnetic field, etc.

The instrument is supplied by Beckman & Whitley Inc., U.S.A.

NEW PRODUCTS IN BRIEF

Induced-roll magnetic separator for the purification and concentration of dry, granular, free-flowing, feebly magnetic materials such as silica sand, feldspar, abrasives, soda ash, manganese, etc. (Rapid Magnetic Machines Ltd.)

★

Graphite, 99% purity, reclaimed from spent residue of graphite barriers used in atomic piles, available for use in the preparation of industrial lubricants, paints, crucibles for metallurgical purposes and as a mould surface coating for use in foundries. (Dohm Ltd.)

★

Laminated plastic usable in the construction of chemically resisting parts and structures. Makers claim it is far stronger than other plastics materials, including laminates with reconstituted fibre reinforcement. (Permali Ltd.)

★

Chemical formulae and equations present a problem in typing out a chemical script on an ordinary typewriter. Realising this difficulty, a German firm have brought out a special keyboard adapted to the requirements of the chemist. (Olympia Werke A.G., Wilhemshaven.)

★

Self-priming fire-fighting pump that can be speedily converted into a mobile set simply by bolting the base plate on to a trailer frame. Pump is close-coupled to a Petter diesel engine. (Pegson Ltd.)

★

New water-soluble whitener, developed to facilitate application procedures of brighteners to wool, nylon, acetate, pure silk and *Orlon* textiles. May be applied by usual dyeing or padding methods. (American Cyanamid Co., U.S.A.)

★

Lightweight flexible hose which, makers state, can be used to transport not only petrol but oil, pure benzole and other chemicals, water, etc. Weight per foot ranges from 0.65 lb. for 1½-in. i.d. hose to 2.9 lb. for 4-in. i.d. (Compoflex Co. Ltd.)

★

Miniature moving-coil relay—a magnetically self-shielded unit capable of operating from a power input of 10 mw. and, the makers state, functioning in any position. Overall measurements of relay are 1⅜ × ¾ × ⅝ in. (Electro Methods Ltd.)

FOR DETAILS OF THE PLANT AND PRODUCTS DESCRIBED, PLEASE USE THE COUPON ON PAGE 278

World News

GREAT BRITAIN

Gas hydration plants for Australia

Head Wrightson Processes Ltd. announce that, in conjunction with the Fluor Corporation Ltd., they have received an order for two gas dehydration plants to dehydrate 18 million cu. ft. of gas each daily for the Gas & Fuel Corporation of Australia. Located at Morwell, the plants will process gas extracted from the brown coal deposits nearby, and supplies will be piped to the city of Melbourne.

Baker Platinum in merger

Baker Platinum Ltd., Hanovia Products Ltd. and Hanovia Ltd. have now linked up as one company under the name of Engelhard Industries Ltd. Baker Platinum is engaged in the refining and fabrication of precious metals; the production of dental golds and amalgam alloys; platinum laboratory apparatus, etc. Other products include the *Deoxo* process for catalytic gas purification and the *Nitroneal* generator. The name Baker Platinum will continue to be used and the organisation will form the Precious Metal Division of Engelhard Industries Ltd.

Hanovia Products is engaged in the manufacture of liquid gold and other liquid preparations for the ceramic trade. Hanovia Lamps is engaged in the manufacture of ultra-violet and infra-red radiation equipment. These two organisations will form the Ceramic and Lamps Divisions of Engelhard Industries, respectively.

Matthew Hall & Co.'s successful year

In his annual review the chairman of Matthew Hall & Co. Ltd. states that the company's Chemical, Oil Refinery and Industrial Engineering Division has been increasingly engaged on the design, procurement, construction and commissioning of process plants including de-gassing columns, a batch distillation unit employing induction heating, double-effect evaporators and sulphur-melting plant.

Other work included erection of sulphuric acid, catalyst production and benzole distillation plants, also rotary kilns each 284-ft. long. In its factories the company manufactured skid-mounted gas-separating stations for Venezuela.

Matthew Hall (Pty.) Ltd., South Africa, doubled its turnover, despite keener competition during the year. The Chemical Division has carried out chemical leadwork for sulphuric acid plants, lead lining of absorption towers for an auto-oxidation plant and lead acid transfer piping for a pyrites recovery plant. Other contracts included work on uranium oxide extraction and concentrate plants, fume removal, scrubbers and building pressurisation for a tungstic acid plant.

Edwards High Vacuum Ltd.

The changing of the company's name to that above was referred to in the annual report of W. Edwards & Co. (London) Ltd. It was also stated that the growing importance of high-vacuum techniques in an ever-increasing number of industrial purposes is leading to a very considerable increase not only in the variety but in the size of the plants which have to be produced, and this in its turn calls for greater factory production area. Work has now commenced on an extension to the new factory at Crawley of about 40,000 sq. ft. and it is hoped that this extension will be completed by the end of the present year.

Atomic energy at work

'Atoms for Peace' is the theme of a mobile exhibition which was in London for 10 days last month and is now on a five-months' tour of Britain. It is sponsored by the United States Information Service in co-operation with the United Kingdom Atomic Energy Authority.

Primarily intended for the layman, the exhibition explains in simple terms the possibilities of atomic energy for peaceful uses, including radio-isotopes in industry. For instance, there are models of radio-isotope containers, Geiger counters, handling tongs and models of a closed tank and oil and water pipes which illustrate how radio-activity is employed to measure level of liquids in closed tanks, to determine different grades of oil flowing through a pipe, and detecting an underground leak without unearthing the water pipe.

Research in ferrous powder metallurgy

At a recent London meeting, convened by the Metallurgy (General) Division of the British Iron and Steel Research Association, some concern was expressed at the limitations imposed by economic considerations on the expansion of the ferrous powder metallurgy industry, and it was generally agreed that there were grounds for co-operative research into the production of commercially acceptable powder. The need for a wider exchange of information about the behaviour of different types of ferrous metal powder was discussed, but it was decided that the value of fundamental research needed further demonstration to justify broad industrial support.

There was a prolonged discussion on the question of establishing a co-operative research organisation, which might cover ferrous, non-ferrous and ceramic powder interests, and eventually the proposition was adopted that '. . . the organisations represented view with favour the suggestion from B.I.S.R.A. that an association should be set up for co-operative research in the powder metallurgy industry.'

Lubricating-oil plant for Iraq

Foster Wheeler Ltd. has been awarded a contract by the Iraq Government for the design, supply and construction of a complete lubricating oil refinery in Iraq to produce 25,000 metric tons p.a. of high-grade lubricants.

The units include: vacuum distillation with fired heater and steam condenser; propane dewaxing; propane de-asphalting with propane preparation plant; furfural refining; acid treating; clay percolation; cooling tower; drum- and can-making plant with filling facilities; water treatment; tankage; and off-site facilities.

Change of name

The Riley Stoker Co. Ltd. announce that the company's name has been changed to Riley (IC) Products Ltd. This step has been taken, having in mind that in addition to mechanical stokers of all types, which was the main interest of the company for many years prewar, it is now interested in kiln firing, incinerators, coal conveying plant, Syntron electric vibratory equipment, etc.

Change of address

Borax Consolidated Ltd. have now moved to Borax House, Carlisle Place, London, S.W.1 (telephone: Victoria 9070).

Gas Council's search for natural gas

A second deep well is to be sunk in the area near Crowborough, Sussex, as part of the Gas Council's five-year search for natural gas.

The site of the second well is about one mile south-east of the first well and work there is likely to go on for about four or five months.

GERMANY

Nitrogenous fertilisers

Ruhrstickstoff A.G., of Bochum, are reported to be producing two new nitrogenous fertilisers, both of which contain magnesium. The first is formulated at 15% nitrogen and 4% magnesium oxide and the second at 10% nitrogen and 8% magnesium oxide.

PAKISTAN

New chemical and sugar plants

Projects of the Pakistan Industrial Development Corporation which have come into production recently include the caustic soda factory and the DDT plant, both at Nowshera, and the first of the ten planned sugar mills at Jauharabad.

TURKEY

Petroleum corporation

A Government-controlled petroleum corporation has been formed in Turkey. It has taken over the petroleum installations and rights of the Institute of Mining Research (M.T.A.). It will be responsible for the exploration, exploitation, production and refining of petroleum, the storing and transporting of petroleum and petroleum products, the establishment of petroleum refineries, the construction of pipelines both above and below ground and of electric installations connected with petroleum production.

The corporation is authorised to set up commercial companies concerned with petroleum, and to participate in the ownership of petroleum companies set up within the country and abroad. The Batman refinery and all other installations established by the M.T.A. will now be controlled by the new corporation.

PORTUGAL

Sulphate-of-ammonia production

The annual reports of the companies Uniao Fabril do Azoto and Amoniaco Portugues give figures for the production of sulphate of ammonia. U.F.A. produced 33,340 tons in 1954, against 19,328 tons in 1953 and 22,220 tons in 1952. A.P. produced 25,398 tons in 1954, against 14,593 in 1953 and 20,983 in 1952.

Shortage of electrical power still prevented factories from working to full capacity, though the position was much better in 1954 than in 1953. Experiments have been carried out for Amoniaco Portugues in West Germany, involving gasification of various types of Portuguese coal as an alternative basis for hydrogen production (instead of electrolysis). These tests are now practically finished and Amoniaco Portugues hope soon to order the plant necessary to enable them to carry out the second phase of development under the Six-Year Plan.

NORWAY

Cement production increases

Norwegian cement production is increasing rapidly and from next year the industry expects that output will be sufficient to meet entire Norwegian needs. Last year, consumption was 938,000 tons, and 155,000 tons of this amount had to be met by imports from Poland, Finland and Germany.

UNITED STATES

New gas pipeline will serve fertiliser plant

South Alberta Pipe Lines Ltd. has been organised by New British Dominion Oil Co. Ltd. and Mid-Continent Oil & Gas Ltd. to carry gas from the Etzikom field of southern Alberta to Medicine Hat, Alberta. The 150,000-million-cu.ft. reserves to be tapped by the line are controlled 65% by New British and 35% by Mid-Continent.

The pipeline will supplement the present gas supply of Medicine Hat on a 15-year contract and will also supply gas requirements of a new chemical plant, to be built by Northwest Nitro-Chemicals Ltd., for production of ammonia fertilisers. The chemical concern, controlled by Commercial Solvents, New British Dominion Oil and others, will commence construction of the facility this summer. Commercial Solvents will manage and operate the new plant, which is scheduled for completion in autumn 1956.

Sulphur project

The Freeport Sulphur Co. will install facilities to produce sulphur from a newly discovered salt dome under water off the Louisiana coast, according to a report from New York. The deposit, known as Lake Pelto, is near the company's Bay St. Elaine mine, about 60 miles south-west of New Orleans. It is under 6 to 8 ft. of water, within a mile of the open Gulf.

Carbon-black dispersions

Another stage in the programme of expansion planned by Acheson Industries Inc. was completed recently when a new plant at Orange, Texas, was opened. The plant will produce concentrated dispersions of carbon black in thermoplastics. The choice of Orange as the plant site was largely governed by the fact that the principal American producers of polyethylene, including Du Pont, Bakelite and Monsanto Chemicals, are concentrated in Texas. These manufacturers have already revealed plans for greatly increased production during the next two years.

The United Kingdom unit of the Acheson Group, Acheson Colloids Ltd., London, has a Dispersed Pigments Division at Slough which produces dispersions of carbon blacks and pigments in water, resins, plasticisers and other carriers.

FRANCE

Petroleum production

In the oil industry, production continues to rise in Alsace, though not in the Pechelbronn field. The Merkwiller refinery is working to capacity; it is intended to incorporate this refinery in a new one to be built in the port of Strasbourg with a capacity of 500,000 tons. At the Lacq natural-gas field in the south-west there are now 23 producer wells, at 14 of which the gas is extracted under its own pressure. A new oil strike is reported at Boos, in the Landes.

New cat cracker

According to a report in the *Financial Times*, the French oil company Shell-Berre, belonging to the Shell-Royal Dutch Group, has started to set up a catalytic cracking unit in its Petit Couronne refinery, near Rouen.

Last year the refinery had a throughput of 2 million tons of crude oil. The new cracking unit will produce 600 tons of high-octane index petrol.

SWEDEN

Fertiliser industry

Following completion of the new ammonia factory at Kvarntorp in central Sweden next year and the expansion of certain other factories, Sweden will be able to produce 55,000 tons of nitrogen p.a., corresponding to 70% of current consumption. Sweden's consumption of nitrogenous fertilisers increased from 5,000 tons in terms of nitrogen content during 1915 to 80,000 tons in 1954. Maximum requirements are estimated at 150,000 tons.

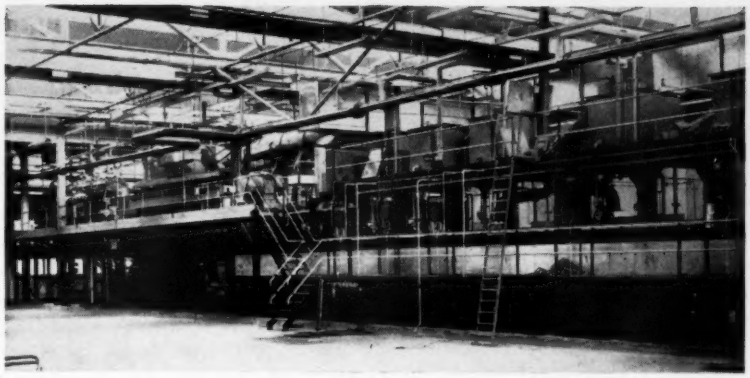
Consumption of potassium fertiliser in terms of K_2O increased from 20,000 tons in 1911-15 to 74,000 tons in 1954, according to a report at a meeting of the Swedish Agricultural Academy in Stockholm. Maximum requirements are estimated at 185,000 tons.

Annual consumption of phosphates now totals about 110,000 tons, while maximum requirements are estimated at 205,000 tons. The total capacity of Swedish factories now amounts to

Courtaulds New Viscose Research Laboratory

THE processes involved in the production on an industrial scale of regenerated cellulose fibres with properties suited to their various uses are complex and inherently difficult to investigate; even after 50 years of research many problems still remain to be solved. In the early days, progress had to be made with little understanding of the molecular changes involved. As the work proceeded, insight deepened, and the time has now come when further progress will depend increasingly on a thorough understanding of the physical and chemical changes which take place during the production of the viscose solution, its extrusion into a coagulating bath and the subsequent regeneration of the cellulose in the form of filaments suitable for textile or industrial uses. It is also necessary to find out what mechanical properties are required for satisfactory performance in these various textile and industrial uses, and to relate them both to the gross and fine structures of the fibre.

The new, recently completed viscose research laboratory of Courtaulds Ltd. should make important contributions to the technical development of the viscose industry as well as to the company's prosperity. The laboratory and its pilot-plant building represent one of the major projects in the company's research expansion programme. They are situated near the older laboratories, adjacent to the Coventry factory—practically all the company's research on viscose in Britain has been carried out there since commercial production of viscose rayon started at Coventry in 1955.



Pilot plant for viscose rayon staple production at Courtaulds' new laboratory.

The new laboratory, which is at present the largest of the company's six laboratories, is concerned almost entirely with the manufacture of fibres by the viscose process. Broadly speaking, its main objects are to effect major improvements in the properties of the fibre and to develop improved methods of manufacture.

Included in the new facilities is a pilot plant for viscose rayon staple production. This plant is capable of producing 20 tons/week of experimental viscose rayon staple for commercial evaluation and use.

130,000 tons of phosphates, of which 13,000 tons consist of basic slag and 117,000 tons of superphosphate. Sweden's iron ore deposits contain extractable phosphate rock equivalent to 200 million tons of 20% superphosphate, or sufficient to cover domestic consumption for about 400 years.

Sweden also has rich lime deposits. However, lime consumption has been decreasing in the last few years.

HUNGARY

Chemical expansion

Hungary's chemical industry has achieved a threefold overall production increase in the past five years. According to a recent survey by the Minister of Chemical Industries and Power, caustic soda, sulphuric acid and oxygen manufacture show a twofold increase during that period. Other increases include: oil paint and lacquer, two and a half times; films, a tenfold increase; and mineral oil, three and a half times. In the past ten years, production of medicines has increased tenfold; vitamins, fivefold; rubber products, sixfold; and alumina, five and a half times.

The Minister stressed the importance of the chemical processing of coal resources. He referred to the rapid development of the plastics industry throughout the world, and he said it was necessary, in order to develop Hungary's textile industry and to maintain its world market competitive capacity, to manufacture, as soon as possible, nylon, *Perlon* and *Orlon* types of artificial threads and their basic materials.

RHODESIA

Water supply installation

The water supply to Salisbury, Southern Rhodesia, combined with the general irrigation scheme on the Hunyani River, provides an interesting example of the utilisation of electric power in the industrial development of Africa. According to the Metropolitan-Vickers Electrical Co. Ltd., who supplied electrical equipment for the scheme, the Hunyani Poort Dam constructed on Lake McIlwaine has a capacity of 55 million gal. The nearby pumping station, comprising a pump house and filtration plant, delivers 400,000 gal./hr.—firstly to the Warren Hills booster station against a head of 476 ft., and from there to Salisbury against a head of 335 ft.

The pipelines are 30 in. in diameter, 81,000 ft. in length from Hunyani Poort to Warren Hills, and 33,600 ft. from the booster station to the municipal reservoir.

At both the pumping and booster stations the pumps are direct-coupled to Metropolitan-Vickers 1,500-r.p.m. synchronous induction motors, of 1,250 h.p. at Hunyani Poort and 880 h.p. at Warren Hills, and with *Vax* control arranged to maintain approximately unity power factor from no-load to full load.

Electricity supply is by overhead distribution, 33 kv. at Hunyani Poort and 11 kv. at Warren Hills, and is stepped down to 3,300 v. for supply to the motors. The present demand of the city of Salisbury is 5½ million gal./day, and it will shortly be necessary to increase the capacity of the pumping station by the installation of a further unit.

Phosphatic fertiliser plans

The Minister of Commerce and Industry said recently that he understood that plans were well advanced by private enterprise for the production of phosphatic fertilisers in the Federation of Rhodesia and Nyasaland. Sir Malcolm, who was speaking in the Federal Assembly, said that should these plans materialise, the Federation expected to produce its

requirements within the next few years.

The possibility of manufacturing sulphate of ammonia within the Federation, he said, had been actively purused for some time, both by the Government and by private interests. In view of the financial implications involved in such a project, it was necessary to be certain of the process of production, and he was arranging for a full technical investigation into the matter.

CANADA

New electro-salt descaling process

Intended to increase efficiency in the manufacture of its tool and many other specialty steel products and to help make Canada self-sufficient in the production of stainless steel, a far-reaching expansion programme is being completed at the Welland, Ontario, works of Atlas Steels Ltd. The programme involves the installation of some of the most modern equipment ever designed for steel production, much of it being revolutionary in character and including several ' firsts ' for Canada. Among these is an electro-salt descaling process the installation for which is believed to be the first of its kind in operation anywhere.

Following casting, the steel for strip production is reheated uniformly, passed through a 2-Hi blooming mill, conditioned by the Linde process of automatic powder scarfing and, after cooling, is descaled by a wheelabrator. The slabs are then reduced in thickness in a planetary mill, annealed and pickled.

After leaving the annealing furnace the steel is quenched by a combination of steam and air or water vapour and passes into the Kolene salt tanks, which are two ' in line,' for descaling. This electrolytic salt descaling unit replaces the conventional mechanical scale-breaking equipment and is particularly useful for the 400-series grades that have an inherently tight scale after annealing which is difficult to remove without injuriously overpickling the material.

Descaling hot-rolled strip by means of molten salt (sodium hydroxide) and the use of electric grids, the unit descales cold-rolled strip by means of molten salt only. The salt is maintained at a temperature of 900°F. by the use of gas-fired burners.

For dealing with hot-rolled strip electric grids are placed in both the No. 1 and No. 2 salt tanks, which are insulated from each other. In the No. 1 salt tank the electric grids are negative, while in the No. 2 salt pot the grids are positive. Thus the strip takes the opposite polarity to the grids, being positive in the No. 1 tank and negative in the No. 2 tank. Because the tanks are insulated from each other the current must flow through the strip to give the desired efficiency.

In the first tank the scale on the strip is oxidised and, when it reaches the second tank, the oxidised scale is dissolved. By using this method of scale breaking and further pickling in one, or a combination, of conventional pickling tanks (hot sulphuric tank, electrolytic sulphur tank or hot nitric-H.F. tank), any desired type of pickle finish can be obtained. Cold rolling and subsequent annealing and pickling followed, perhaps, by further rolling on a 2-Hi skin pass mill completes the process.

Lithium concentrates

Quebec Lithium Corporation has announced plans for the construction of a 1,000-ton/day milling plant to produce lithium concentrates.

The Leonard Hill Technical Group—July

Articles appearing in some of our associate journals this month include:

Food Manufacture—Deep-freezing by the Protan Method; Packaging Odour and Flavour Problems; Pickle Making; Advances in the Biochemistry of Vitamins in India; Method for Determining the Meat Content of Bean, Pork Sausage and Tomato Sauce; The de Jersey Continuous Crumpet Machine; Fish Canning in Yugoslavia; Fungal Enzymes in Bread Production.

Manufacturing Chemist—Artificial Jasmin Oil; Chemotherapy and Selective Toxicity, 4—Some Physico-Chemical Aspects; Rheological Aspects of W/O Emulsions; The Vitamins, Recent Research, 2; Progress Reports: Cosmetics and Toilet Preparations; Antibiotics.

Paint Manufacture—The Detection of Polyvinyl Butyral; Daylight Fluorescent Colours; Economics of the Paint and Varnish Industry in Europe; Paint Manufacture in Belgium; Technical Advances in Europe; Reviews of the Achema Exhibition, Fatipec Congress and the O.C.C.A. Conference.

Petroleum—Direct-Fired Heaters in Chemical Engineering; The Fourth World Petroleum Congress, Rome, 1955; Planning of Service Tests with Lubricants; Spectroscopy in the Oil Industry, 2.

Fibres—Industrial Uses of Artificial Fibres, 1; Second International Textile Exhibition, Brussels; Technical Progress in Man-Made and Synthetic Fibre Production, 2; Courtaulds' New Viscose Research Laboratory; Fibre Data Sheet: Polyacrylonitrile Fibres; 40th Annual Conference of the Textile Institute—Practice and Progress.

Progress in Water-Pollution Control

(*Concluded from page* 271)

used in the experiments was 4-ft. deep and rather more than 0.25 in. in diameter, and it contained 40 ml. of a granulated alumina of the type normally supplied as a desiccant; all the material passed a 16-mesh sieve and was retained on a 32-mesh sieve. Water containing fluoride was passed downward at a controlled rate and when the bed was exhausted it was regenerated by backwashing with a 0.75% solution of sodium hydroxide, followed by rinsing with dilute sulphuric acid and water.

Preliminary tests have shown that there may be appreciable variations in the capacity of activated alumina to remove fluoride from different types of water; it seems to be removed more readily from a hard water than from a soft one with a relatively high *p*H value and high chloride content.

CHEMICAL & PROCESS ENGINEERING

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